THE

TECHNIC OF OPERATIONS

UPON THE

INTESTINES AND STOMACH

BY

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OF BOSTON

With 190 Illustrations, Mostly Original
Several of Them in Colors

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PREFACE

Three years ago I began an experimental study of gastro-intestinal technic. The animals used for the experiments were mainly dogs, although cats were employed for certain operations.

The object of the experiments was to simplify, where possible, the best gastro-intestinal operations. After careful study of an operation upon animals, the method was tried again upon the cadaver, for anatomical corrections.

In this book, which is the result of three years of research, are collected certain of the standard operations upon the intestines and the stomach.

No pretence is made of giving all of the methods in vogue, and many well-known operations have been omitted to give more room for illustrating the methods which were chosen. It is believed, however, that a knowledge of the technic, here included, will enable the surgeon to meet practically all of the requirements of gastro-intestinal surgery.

I feel under the deepest obligations to Miss Florence Byrnes and to Mr. H. F. Aitken for the painstaking manner in which they have made their beautiful drawings. Certain of the drawings are modifications, or are copies of others already in print; credit is given to such drawings in the legends.

Through the generosity of my publishers I am able to add seven colored anatomical plates from Sobotta's "Atlas and Text-book of Human Anatomy," which illustrate certain important surgical landmarks.

The work on repair, in Chapter I, was done conjointly with Dr. F. B. Harrington, and is produced here with his permission. In fact, Dr. Harrington's suggestions have been so numerous and so valuable that the scope of the book has been greatly increased thereby. Prof. E. H. Nichols first suggested and then directed the experiments for the study of repair, a service for which I am greatly in his debt.

Through the kindness of Dr. F. T. Murphy I am able to reproduce his original microscopical drawings, illustrating repair following the use of the elastic ligature.

For the reproduction of the drawings upon the repair following the Murphy button I am indebted to Dr. J. H. Barbat, of San Francisco, who

obligingly furnished me photographs of his sections, from which the drawings were made.

The facts embodied in the discussion of intestinal localization are taken from the monographs of Dr. G. H. Monks, by whose courtesy I have been permitted to reproduce ten of his original drawings.

Dr. Mixter has been most obliging in allowing me to publish his technic on colostomy, before he has done so himself.

The interest shown by Professors Warren and Burrell encouraged me to attempt the task of writing a book, and their many kindnesses are gratefully acknowledged.

In the preparation of the manuscript, many works have been consulted, among the authors of which are: Tillmann, Bickham, Robson and Moynihan, Gant, Cheyne and Burghard, Poirier, Delamere and Cunéo, Hartmann and Cunéo, Terrier and Baudouin, von Frey, Binnie, Moynihan, Connell, Gray, Quain, Téstut, Tillaux, Sobotta, Stöhr, Piersol, and many reprints.

Personal communications from Doctors Finney, McGraw, W. J. Mayo and Connell have contributed valuable opinions which are embodied in the text, where they are referred to in detail.

I wish to thank Dr. William C. Quinby for his careful correction of the manuscript and of the proof.

48 Beacon Street, May, 1906.

TO

Charles Burnham Porter, M.D.

FOR SIXTEEN YEARS

PROFESSOR OF CLINICAL SURGERY

AT

HARVARD UNIVERSITY.

CONTENTS

CHAPTER I

CHAPTER II

CHAPTER III

CHAPTER IV

LIST OF ILLUSTRATIONS

THE

TECHNIC OF OPERATIONS

UPON THE

INTESTINES AND THE STOMACH.

CHAPTER I.

THE REPAIR OF INTESTINAL WOUNDS.

THE STRUCTURE OF THE INTESTINES AND OF THE STOMACH.—THE BLOOD-VESSELS OF THE INTESTINES AND OF THE STOMACH.—THE LYMPH-VESSELS OF THE INTESTINES AND OF THE STOMACH.—EXPERIMENTAL RESEARCH ON REPAIR.

THE STRUCTURE OF THE INTESTINES AND OF THE STOMACH.

(FIGS. 1 AND 2.)

In order to understand the repair of intestinal wounds, a knowledge of the histology of the gastrointestinal canal is necessary. A brief description of the histology of these organs is given below, which has been taken, chiefly, from Stöhr[1] and Piersol.[2]

The stomach and the small and the large intestines are composed of four coats, the serous, the muscular, the submucous, and the mucous. Although the characteristics of the individual layers change somewhat according to the digestive functions which they are required to perform, these variations are not of importance in the process of repair.

The external, or serous, coat is derived from the peritoneum, and "consists, principally, of fibrous connective tissue and numerous elastic networks; the free surface is covered by a simple layer of flat polygonal cells" (Stöhr).

[1] Stöhr. Text-Book of Histology, p. 162.
[2] Piersol. Normal Histology, p. 174.

The muscular coat consists of a thick inner circular layer, and a thin outer longitudinal layer. In the stomach the arrangement is varied by the addition of a third layer of oblique fibers, which is derived from the esophagus. In the colon the longitudinal muscle-fibers are collected mainly

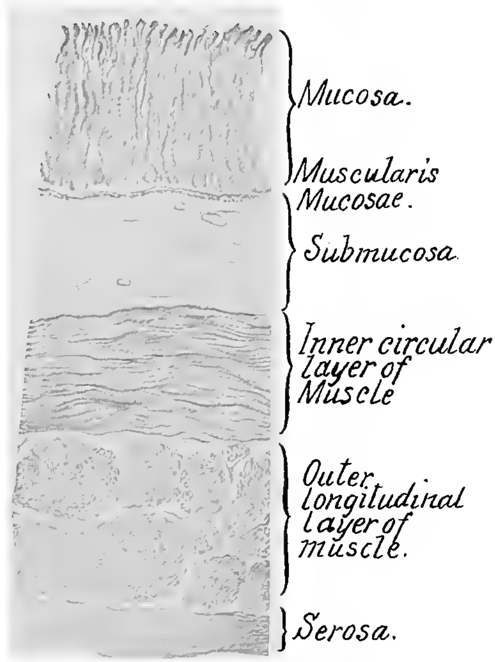


FIG. 1.—TRANSVERSE SECTION OF HUMAN STOMACH. × 16. (After Stöhr.)

FIG. 2.—LONGITUDINAL SECTION OF HUMAN JEJUNUM. × 16. (After Stöhr.)

into three flat bands which are placed on the mesenteric, the anterior, and the inner borders of this portion of the large intestine.

The submucous coat is composed of loosely united connective tissue-bundles, and elastic fibers, and occasionally contains small clusters of fat cells.

The internal, or mucous, coat is soft, highly vascular, and covered with epithelium which varies markedly according to its situation in the digestive tube. In it are placed the glandular elements which take part in the digestive process. The glandular layer of the mucous membrane is separated from the submucosa by two thin layers of smooth muscle-fibers called the *muscularis mucosæ*, and, from this layer, other muscle-fibers are given off which interlace among the glands of the mucous layer proper. The muscularis mucosæ achieves its great importance from its tough structure, which is peculiarly adapted to resist the pull of a stitch. It is the only portion of the intestinal wall which has this valuable quality.

THE BLOOD-VESSELS OF THE INTESTINE AND OF THE STOMACH.[1]

The blood-vessels of the stomach and of the large intestine have a precisely similar distribution, which is modified in the small intestine by the presence of the villi.

Upon entering the serosa of the stomach and of the large intestine the arteries give off small branches to the serosa, thence, piercing the muscularis, which they also supply, they pass to the submucosa to form a network which is placed within this layer parallel to the surface of the bowel. In the healing of intestinal wounds it will be seen later that the vessels which take the most active part in the process arise from the submucosa.

The small branches which arise from the submucous plexus ascend through the mucous membrane and from another network in the *tunica propria* at the base of the glands. The gland-tubules and crypts are supplied from this plexus.

The vessels of the small intestine which supply the crypts are distributed in the same manner as in the large intestine. The vessels are otherwise changed to adapt themselves to the special anatomy of the small intestine,—*i. e.*, villi, glands of Brunner, lymph-nodes, etc.

THE LYMPH-VESSELS OF THE INTESTINES AND OF THE STOMACH.[2]

The lymph-vessels of the stomach and of the large intestine take their origin in the mucous membrane as blind capillaries, and descend between

[1] Stöhr. Text-Book of Histology, p. 168.
[2] Stöhr. Text-Book of Histology, p. 169.

the gland-follicles. In the mucous membrane of the small intestine the lymph-vessels begin in the axes of the villi. All these vessels descend and join in a capillary plexus lying at the base of the glands. This plexus extends parallel to the surface and communicates by numerous anastomoses with a wide-meshed plexus in the submucosa. Proceeding from this network, the lymph-vessels penetrate the muscular coat, receiving tributaries from the plexus situated between the circular and the longitudinal muscular strata, the so-called intramuscular lymphatic plexus, which receives the lymph supply from both muscular layers. The vessels run beneath the serous coat to the mesenteric border, and pass on between its layers.

EXPERIMENTAL RESEARCH ON REPAIR.

The study of repair which follows was done with Dr. F. B. Harrington in the Laboratory of Surgical Pathology at Harvard Medical School.[1] The data was obtained from three sources:

(1) A series of twenty-two experiments upon fourteen dogs and four cats. In these animals the anastomoses were made with the assistance of the Harrington segmented ring.

(2) A series of experiments upon ten cats and three dogs. These experiments were not done primarily for the study of repair, but had in view the working out of certain technic in the operation of gastroenterostomy. These experiments were done without the aid of a mechanical device. Specimens taken from these animals were used for comparison with the first series.

(3) Sections of anastomoses done on human beings, kindly furnished by Dr. Nichols.

EXPERIMENTS WITH THE SEGMENTED RING.

The technic for introducing the ring and performing the anastomosis is briefly as follows:

(1) The cut bowel-ends are fastened over the ring by means of soluble purse-string sutures. These sutures perform the double duty of attaching the bowels to the ring, thus facilitating the introduction of the mesenteric

[1] Harrington and Gould. Annals of Surgery, November, 1904.

and the peritoneal stitches, as well as of holding the segments of the ring together during the first four or five days succeeding the operation.

(2) The Maunsell mattress-mesenteric stitch is used to bring together the mesenteric borders, after tying the purse-strings.

(3) The peritoneum is approximated with a continuous Cushing right-angle suture. The suture material used for the purse-strings was No. 2 plain catgut; for the mattress-mesenteric stitch, No. 1 chromic catgut; for the Cushing right-angle stitch, No. 1 Pagenstecher's celloidin linen thread. A complete illustrated description of the three stitches mentioned above is to be found in Chapter II.

TABLE OF EXPERIMENTS WITH THE SEGMENTED RING.

End-to-end intestinal anastomoses	8
Lateral intestinal anastomoses	3
Gastrointestinal anastomoses	7
	18
Gastrogastrostomies	4
	22

END-TO-END. (DOGS.)

Exp.	*Time elapsed after operation.*	*Condition of suture at autopsy.*	*Segments found.*
1.	1 day	Intact	At site of suture.
2.	1 day	Intact	At site of suture.
3.	3 days	Slough of suture, too large ring[1]	At site of suture.
4.	7 days	Intact	Ileum.
5.	7 days	Intact	Two in ileum, two in rectum.
6.	8 days	Intact	Ileum and rectum.
7.	14 days	Intact	Not found (passed).
8.	42 days	Intact	Not found (passed).

LATERAL INTESTINAL. (DOGS.)

9.	5 days	Intact	Near suture.
10.	10 months	Still alive	
11.	12 months	Still alive	

GASTROENTEROSTOMIES. (DOGS.)

12.	3 days	Intact	Three in pylorus (stomach), one in small intestine.
13.	7 days	Intact	Ileum.
14.	7 days	Intact	Ileum.
15.	10 days	Intact	Rectum.
16.	12 days	Intact	Large intestine and rectum.
17.	14 days	Intact	Three in large intestine and rectum.
18	21 days	Intact	Not found (passed).

[1] The intestine in this case was so stretched over the ring that it was anæmic. As it was an early case, the importance of breaking down the ring under such circumstances was not recognized.

GASTROGASTROSTOMIES. (CATS.)

To determine how long ring remains in situ.

1.	24 hours	Intact	Segments held firmly in place.
2.	3 days	Intact	Segments held firmly in place.
3.	5 days	Intact	Segments still in place, loosely.
4.	6 days	Intact	Ring broken down, segments all in situ.

EXPERIMENTS WITH THE PLAIN SUTURE.

When an anastomosis is performed without the aid of a mechanical device it is customary to employ two layers of stitches: an inner continuous stitch which penetrates all coats, and brings together the cut edges; an outer stitch, either continuous or interrupted, for approximating the peritoneal surfaces around the joint. The second series of experiments of ten cats and three dogs was done with the plain suture technic.

TABLE OF EXPERIMENTS WITH THE PLAIN SUTURE.

Expt.	*Time elapsed after operation.*	*Condition of suture at autopsy.*	*Operation.*
		CATS.	
1	15 hours.	Intact.	Anterior Gast. Ent.
2	24 hours.	Intact.	Anterior Gast. Ent.
3	3 days.	Intact.	Anterior Gast. Ent.
4	7 days.	Leak.	Anterior Gast. Ent.
5	17 days.	Intact.	Anterior Gast. Ent.
6	21 days.	Intact.	Anterior Gast. Ent.
7	39 days.	Intact.	Anterior Gast. Ent.
8	6 weeks.	Intact.	Anterior Gast. Ent.
9	10 months.	Intact.	Anterior Gast. Ent.
10	17 months.	Intact.	Anterior Gast. Ent.
		DOGS.	
1	3 weeks.	Intact.	Posterior Gast. Ent.
2	6 weeks.	Intact.	Anterior Gast. Ent.
3	16 weeks.	Intact.	Posterior Gast. Ent.

The repair following the use of the two layers of stitches was found to be practically identical with that following the use of the ring, thus showing that an inner layer of stitches has little influence upon the healing of the wound. The facts given below may be regarded, therefore, as characteristic of repair succeeding the use of the plain suture in two layers, as well as after the use of mechanical devices which demand but one layer of sutures. Three drawings were made from this series.

The sections taken from human beings were four in number, and consisted of end-to-end anastomoses, of two days, four days, seven days, and ten days, respectively.

Details of the Repair.—The close approximation of two serous surfaces, which is characteristic of intestinal sutures, results in a rapid exudation from the apposed surfaces. This exudation appears in a very few hours and hermetically seals the wound. Every coat of the bowel is soon penetrated by this exudate, rapidly destroying the endothelium on the outside of the bowel.

Repair of the Mucous Membrane.—For the first few hours after the suture the mucous membrane is the seat of a marked active hyperemia with more or less bloody extravasation, the mucous edges being dark red and elevated from the coats below. This condition is followed by an exudation which extends into the glandular tissue until, at the end of three days, the glands disappear about the cut edge for two to five millimeters. When a large invagination has been made, in the process of suture, the submucosa becomes so swollen and edematous that it probably interferes thereby with the circulation of the mucous membrane. Under such conditions the slough of the mucous membrane is correspondingly extensive. The amount of destruction of mucous membrane varies somewhat; but usually the slough is about three to five millimeters in width. At the end of five days, the slough generally separates, leaving a clean line. The above series of changes takes place in all sutures, although a separate suture of the mucous membrane seems distinctly to retard the repair for reasons given later.

The reproduction of glands is more rapid in end-to-end than in lateral sutures. If the inturn has been a moderate one, the mucous membrane will cover in the ulcer in about eight days. The glands themselves, though atypical in shape, possess all the characteristics of mucous glands. At the end of eight days the line of suture is represented by a narrow scar situated in the middle of what was formerly the ulcerated area. After gastroenterostomy and lateral intestinal suture, the cleaning away of the slough takes place quickly; but the subsequent ingrowing of the mucous membrane is slow, since the interval to be crossed is a wide one. The process is exactly analogous to the healing of a superficial ulcer on the surface of the body. In these cases mitotic figures were seen at the end of five, but were numerous only at the end of ten days. The nuclear division, as a rule, first came in the mucosa of the stomach. On the tenth day a single line of cells starts

from the stomach and rapidly crosses the floor of the ulcer. The complete closing in of the bare area is much hindered by the presence of sutures, which, even though absorbed, leave irregular holes that are but slowly smoothed over. At the end of twenty-one days the line of suture is covered by a continuous though low mucous membrane. The line of demarcation between the stomach and intestinal glands is a sharp one, and is situated near the center of the old ulcer. These glands, though atypically shaped, have normal functional power (goblet cells, etc.) (Figs. 3 to 10 inclusive).

The new mucous membrane has no definite muscularis mucosæ. At first it rests upon a base of dense granulation tissue. This coat is very slow to repair; but, at the end of six weeks, a substitute muscularis mucosæ has been acquired, which consists largely of connective tissue, but in which are found fibers closely resembling smooth muscle. This layer has no sharp limits, and fades away into the scar tissue beneath.

Repair of the serous surfaces.—The formation of plastic exudate does not cease with the resulting adhesion of the inturned serous coats, but appears externally for a distance of three to five centimeters beyond the line of suture, thus acting like an external callus. The transformation of the exudate into granulation tissue is rapid. In three days a large number of new connective-tissue cells have been laid down, among which are a few new blood-vessels arising from the vessels in the underlying muscular coat. Entire organization of the inner exudate requires at least seven, the outer at least ten, days. After complete organization, the connective tissue gradually disappears, finally remaining as a thick scar, which reaches for a varying distance over the adjacent bowel and, dipping down into the depth of the suture, holds the bowel walls firmly together by thick strong bands. Fourteen days are required for the completion of this sequence.

Repair of muscular coats.—The muscular coats play a passive rôle during the first forty-eight hours after the suture. The muscle-bundles are penetrated by extravasated blood and by exudate throughout their whole thickness. After the second day new blood-vessels bud out into the exudate and assist in its organization. When the inflammatory process has subsided, the muscle-ends are held together by scar tissue arising from the intermuscular connective tissue. This rapidly contracts and approxi-

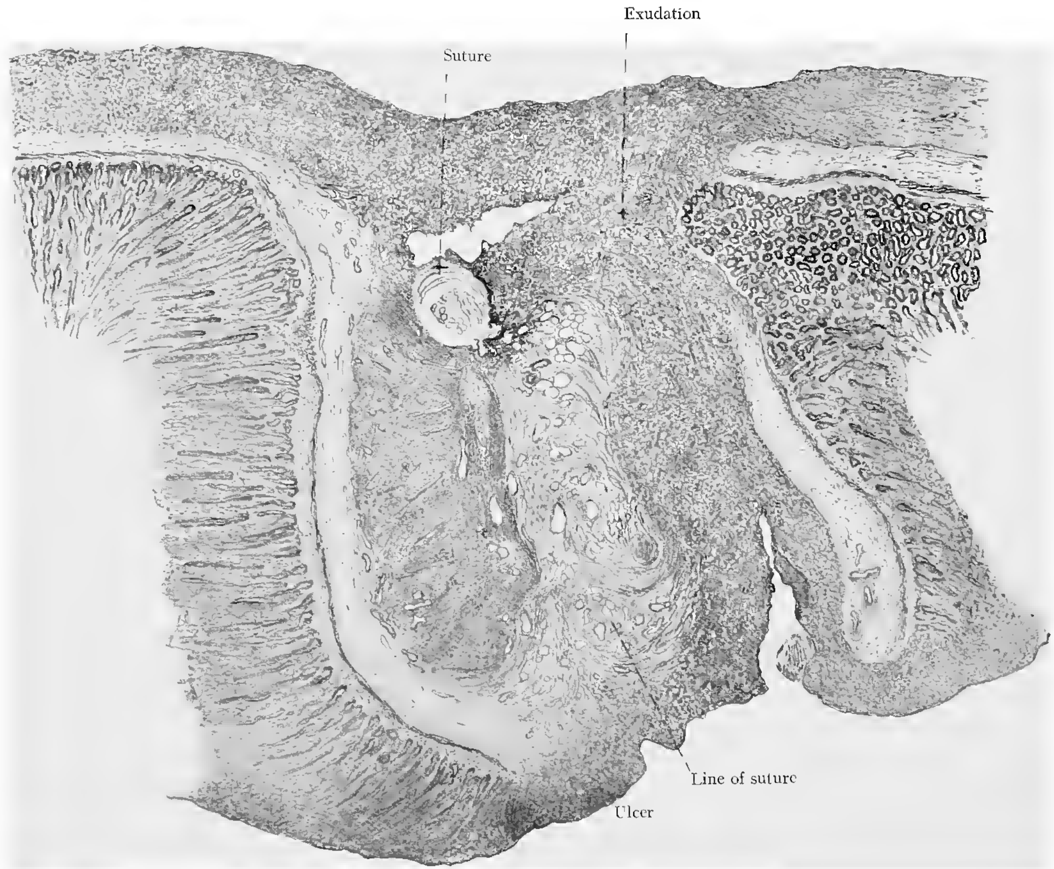


FIG. 3.—END-TO-END ANASTOMOSIS, THREE DAYS.

Note ulcer over inturned edges. Glands of mucous membrane on either side of ulcer necrotic and infiltrated. (Harrington and Gould.)

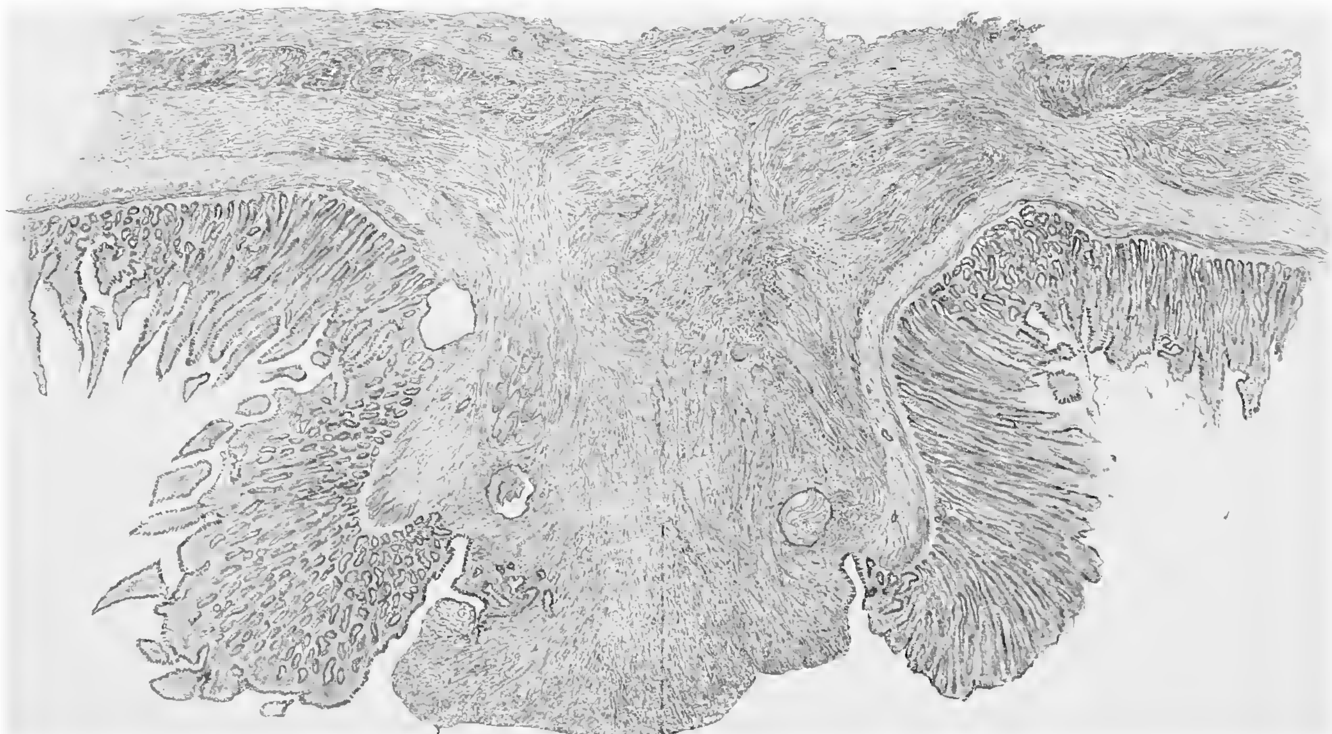


FIG. 4.—LATERAL INTESTINAL ANASTOMOSIS, FIVE DAYS.
Exudation almost entirely organized. Ulcer of denser fibrous tissue, new formation of mucous glands at margin.

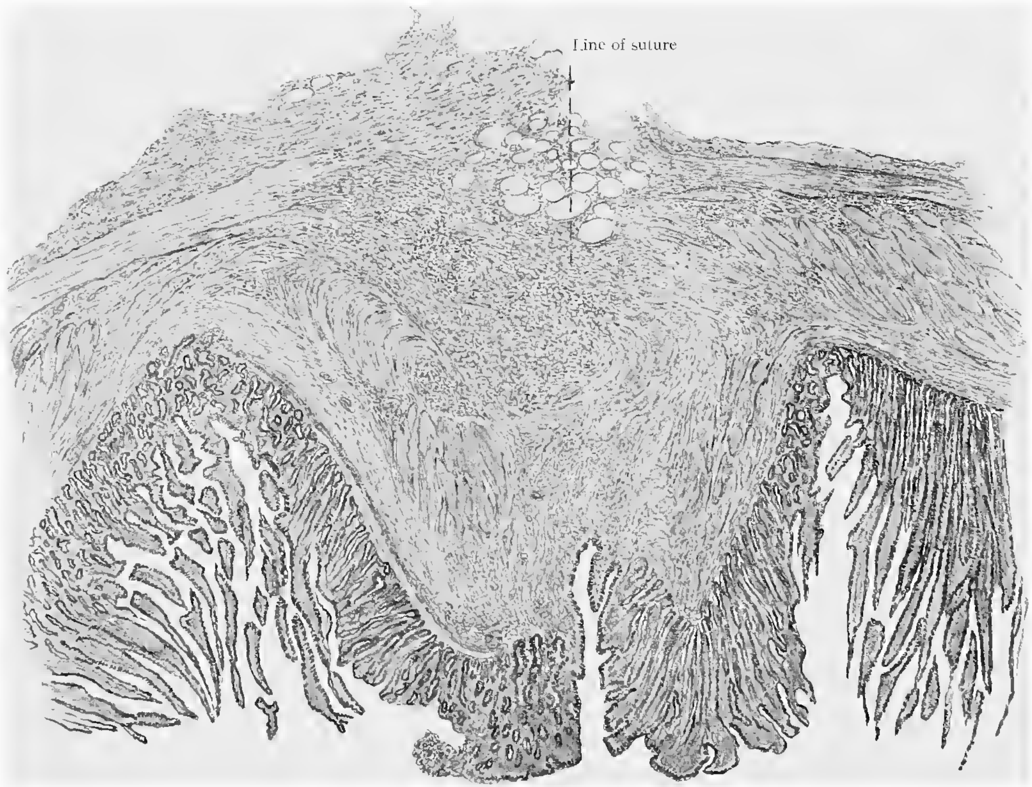


FIG. 5.—END-TO-END ANASTOMOSIS, EIGHT DAYS.

Exudation entirely organized. Ulcer covered by newly formed atypical mucous glands.

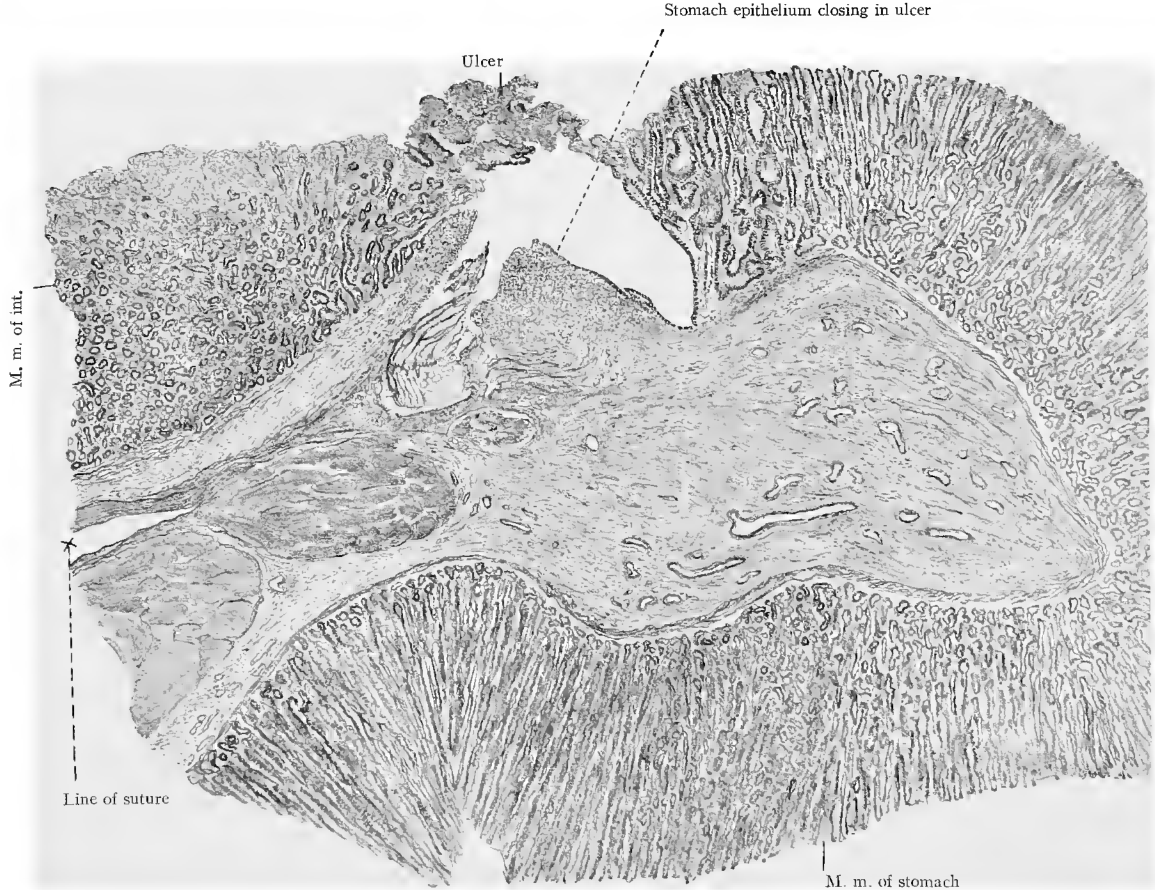


Fig. 6.—Gastroenterostomy, Twelve Days.

Floor of ulcer formed by infiltrated granulation tissue and covered by epithelial cells arising from epithelium of the stomach. Observe that rate of growth of gastric is much more rapid than that of the intestinal epithelium.

Line of suture

FIG. 7.—END-TO-END ANASTOMOSIS, FOURTEEN DAYS.

Marked diaphragm. Granulation tissue contracted down to a dense scar. Diaphragm entirely covered by newly formed atypical glands. Marked inequality in the amount of the intestine inverted on the two sides.

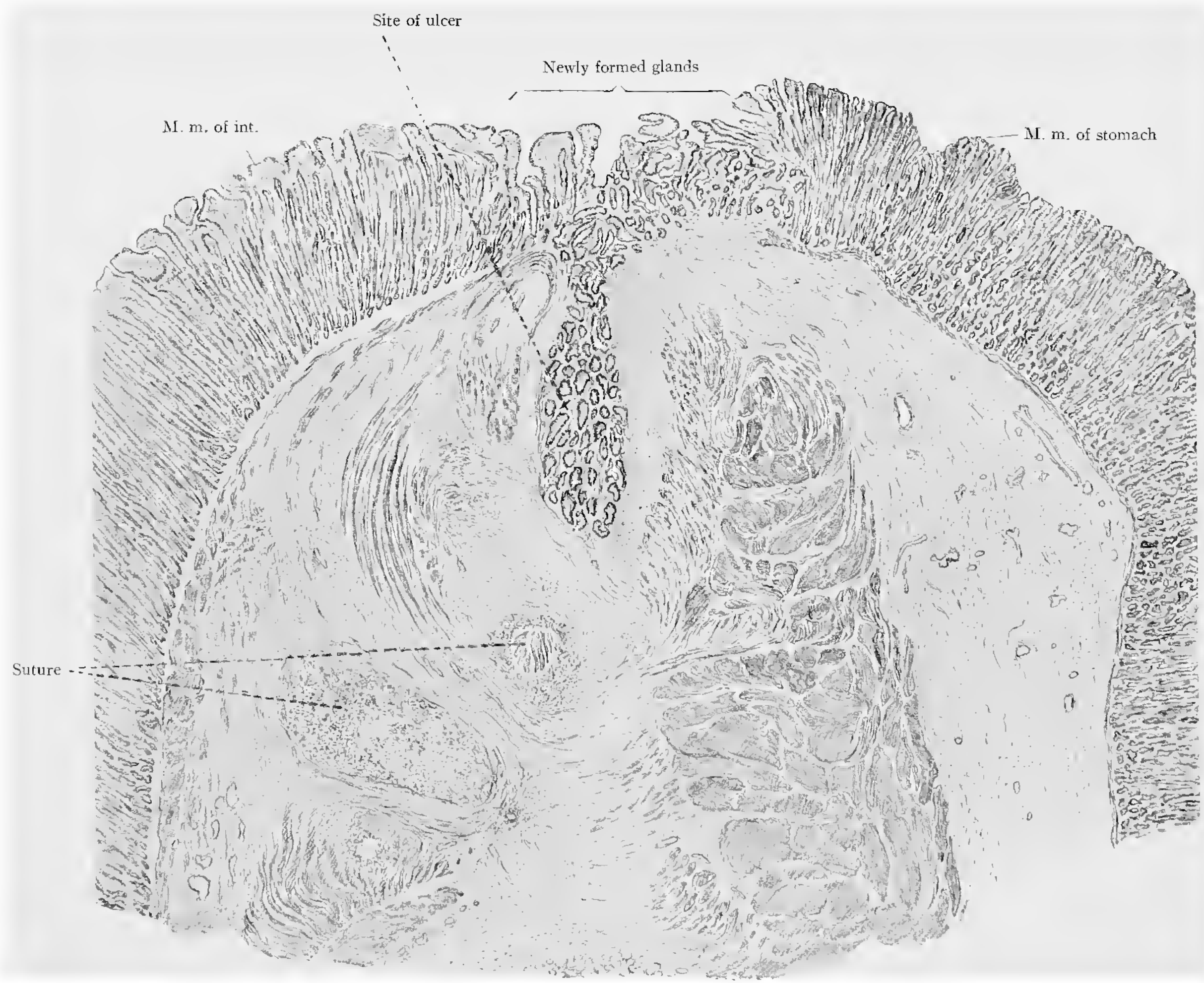


FIG. 8.—GASTROENTEROSTOMY, TWENTY-ONE DAYS.

Suture held together by dense fibrous tissue, except at the edges, which are covered on both sides with new mucous membrane. Note atypical crypts at site of ulcer.

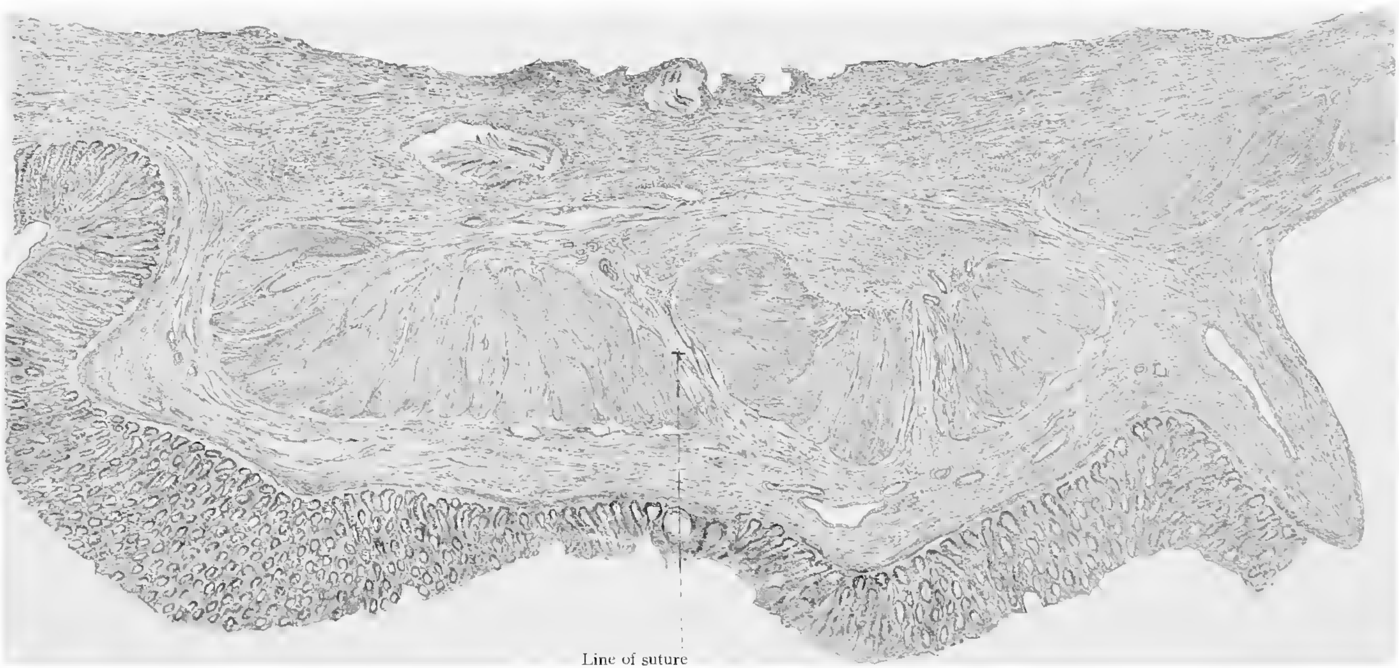


FIG. 9.—END-TO-END ANASTOMOSIS OF LARGE INTESTINE, SIX WEEKS.

The scar is reduced to a thin fibrous line. Inner surface entirely covered with newly formed atypical mucous membrane, thick subserous scar formation (external callus).

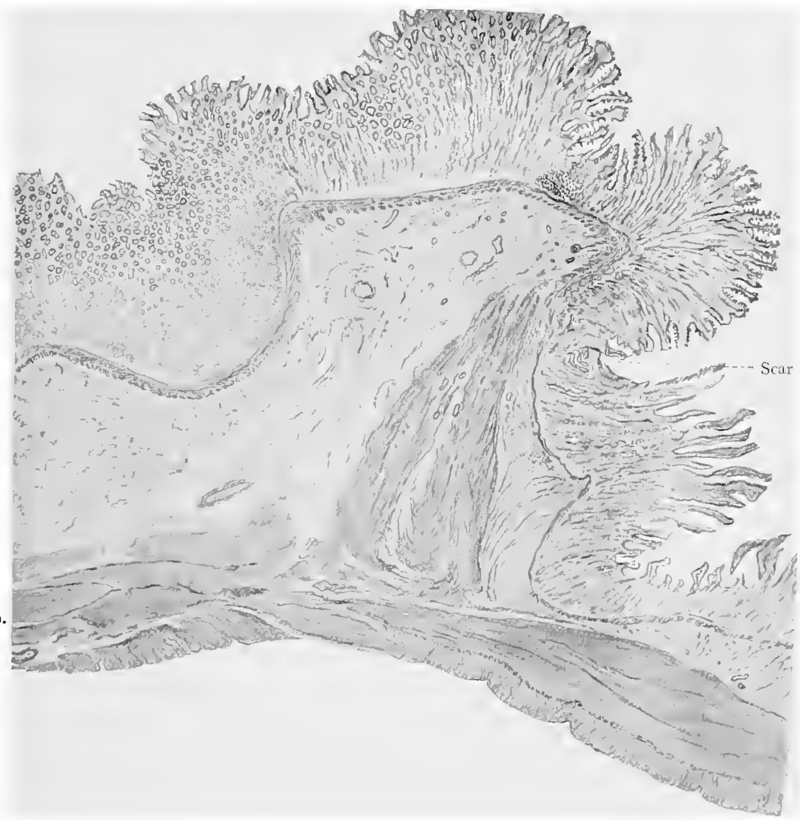


FIG. 10.—ANTERIOR GASTROENTEROSTOMY, BY PLAIN SUTURE, SEVENTEEN MONTHS AFTER OPERATION.

Note the great width of the submucosa, that the muscularis mucosæ has not yet reproduced itself; that the peritoneal surface of the anastomosis has disappeared, the latter being due to adhesion to the omentum. The omental adhesions have been lost in making the section.

mates the separated muscle-ends, so that the ultimate scar is an extremely narrow one and may be entirely unrecognizable by the naked eye.

Repair of the submucosa.—The loose texture of the submucosa allows easy entrance to the exudate. Almost at once this layer becomes distended and edematous for several centimeters on either side of the wound. At the end of the inturned bowel this layer is often as thick as all the others combined. As organization proceeds, the submucosa is filled with large and small blood-vessels and young connective-tissue cells which, running parallel to the surface of the bowel, grow out into the exudate in the bottom of the ulcer, thus forming the base of the internal ulcer. Ultimately the ulcer is converted into scar tissue and is covered by an atypical mucous membrane. From comparison with a limited number of clinically successful intestinal anastomoses in human beings, it seems that the analogy of the process in these animal experiments and in human beings is a very close one, both in histological and in gross appearances.

Mall's experiments.—Mall's experiments[1] with animals, in 1887, led him to divide the repair of intestinal wounds into the following stages:

(1) An immediate fibrous union of the serous surfaces.

(2) A destruction of the protruding parts between the two flaps of the mucosa. This destruction is brought about in two ways: *a*, necrosis, *b*, the destroying power of those crypts which have returned to their embryonic type.[2]

(3) Regeneration of the mucous membrane. Soon after the intestine is sutured, the cut ends of the mucous membrane are destroyed. The bases of the crypts, however, seem to be more resistant and soon show many karyokinetic figures within the epithelial cells. The multiplication of cells in this portion, which is probably only an exaggeration of the normal process, soon causes this layer to spread in all directions. These cells cover the whole surface within their reach, besides sending cystiform invaginations into the tissue. This growth continues until it meets cells from the opposite side, when, of course, it cannot go further. The epithelial

[1] F. Mall. Johns Hopkins Hospital Reports, Vol. I, p. 76.

[2] *Ibid.* Mall explains more fully in the text the process by which these crypts return to the embryonic type. When the submucosa is torn by the needle, a fissure is made which heals by granulation. In the granulation tissue filling these fissures the crypts are frequently embedded, being lined with a single layer of cells of the embryonic type. This is shown in Figs. 4 and 8 of my sections.

covering at once sends invaginations into the tissue which are converted into crypts, between which newly formed villi arise and grow into the lumen of the intestine. If the conditions are favorable, the mucous membrane is fully regenerated at the end of three weeks.

(4) Straightening of the suture. During the fourth week the stitches begin to lose their hold in the submucosa, thus allowing the intestine to straighten out. While the regeneration of the mucosa is taking place, the submucosa of one side is being united by fibrous tissue with the submucosa of the other. The straightening of the suture now allows the ends of the muscle-coats to be arranged in a straight line, besides placing the embryonic mucosa under a greater pressure, thus favoring its maturation. Before the straightening is complete there is a regeneration of muscular tissue, most marked in the muscularis mucosæ.

The **stratum fibrosum**[1] is most resistant and does not begin to regenerate until the sixth week. Up to this time its edge is marked by a sharp border, which, during the sixth week, becomes less defined and projects across the line of suture.

At the end of two months all the coats are fully regenerated and the line of suture can hardly be made out microscopically, while macroscopically it is marked by a thickening of the intestinal walls.

In comparing Mall's results with my own, a few discrepancies will be found. I have not been able to demonstrate repair of the muscularis mucosæ in any specimen, whether done with the segmented ring or by plain suture. On the contrary, Mall's sections showed that both strata of muscle-fibres which make up this layer had been reproduced. Attention is called to Fig. 10, a specimen obtained seventeen months after operation (gastro-enterostomy). The scar joining the cut ends of the muscularis mucosæ consists wholly of connective tissue; there is no evidence whatever of muscle-fibres at the point of union.

The time required for the regeneration of the mucous membrane with closure of the internal ulcer, was rather longer in Mall's specimens than in my own. In the latter the internal ulcer was covered with mucous membrane in seven days, as a rule, though this layer continued to grow in thickness for another week. The period set by Mall for complete regener-

[1] For the histology of the dog's intestine see Abhandl. d. K. S. Ges. d. Wiss., 1887, Bd. XIV.

ation of the mucous membrane is three weeks, but a comparison is unsatisfactory since the exact moment of complete restoration of the mucous membrane is impossible to determine.

Loosening of the seromuscular stitches, with consequent straightening of the joint, was not seen in any of my experiments, although observed by Mall four weeks after the original anastomoses. Other than the differences mentioned above, the facts observed in the two series of experiments are practically identical.

Peptic Ulcer of the Jejunum.—One of the rare complications which follows gastroenterostomy is peptic ulcer of the jejunum. Tiegel[1] has collected twenty-two cases of this sort. He omitted, however, to include in his list two cases described by Robson[2] in 1904, which makes a total of twenty-four reported cases.

Frequency.—Kausch[3] in 1900 reported two cases in a series of one hundred and sixty gastroenterostomies done in the clinic of Professor Mikulicz. As reported by Watts[4] this is probably too small a proportion.

The age of the patients varied between four months (Mikulicz's case) and fifty-nine years, the majority of the patients, however, being more than thirty years old and of the male sex.

Etiology.—Tiegel calls attention to the fact that the original gastroenterostomy was always done to relieve benign disease of the stomach, usually pyloric stenosis. In one case the stenosis was congenital, in another the ulcer was in the duodenum. *The acidity of the gastric juice* has always played a prominent rôle in the theoretical explanation of the cause of peptic jejunal ulcer. In Tiegel's series the stomach contents were examined in only a small number of cases. The results showed that hydrochloric acid was present in excess in some, while in others it was diminished, the majority being in the favor of hyperacidity. Certain cases which were examined in the interval between the first operation and the onset of the symptoms of secondary ulcer, showed some subacidity, others hyperacidity.

Robson[5] believes that the true cause of peptic ulcer, whether gastric,

[1] Tiegel. Mittheilungen a. d. Grenzgeb. der Med. und Chir., Vol. XIII, 1905, p. 897.

[2] Robson. Annals of Surgery, 1904, Vol. XL, p. 186.

[3] Kausch. Verhandl. d. Deutsch. Gesellsch. für Chir., Bd. XXVIII, 1899, S. 74; Bd. XXIX, 1902, S. 140, and Bd. XXXI, 1902, S. 115.

[4] Watts. Johns Hopkins Hospital Bulletin, July, 1903.

[5] Robson. Loc. cit.

duodenal, or jejunal, is probably due to a mild form of *sepsis* which leads to gastritis and an excess of hydrochloric acid in the gastric juice.

Kocher[1] thinks that the acid gastric juice may stimulate *circular contraction of the duodenum* just below the stomach with the formation of a kind of cul-de-sac where contact with the gastric juice may be prolonged, and give rise to ulceration. He claims to have seen such contractions several times in cases of gastroenterostomy which he has explored.

Traumatism of the abdomen preceded one of Hahn's[2] cases, and for this reason was believed by him to have led directly to the condition.

On the whole we can draw no definite conclusion in regard to the etiological significance of hyperacidity of the gastric juice.

Tiegel regards the effect of *circulatory disturbances* upon the attached intestine as important possible causes of secondary ulcer (Virchow[3]). Some light is shed on the subject by noting the methods used for performing the primary gastroenterostomy. In sixteen cases (eighteen, with Robson's two cases), the anterior method of anastomosis was adopted, in seven of which an additional enteroenterostomy was done, including one Y operation of Roux. In five cases the operation was retrocolic and posterior, but with a longer intestinal loop than that used at the present.

Welch[4] found that out of 793 cases of peptic ulcer of the stomach, collected from the statistics of the Johns Hopkins Hospital, 288 were on the lesser curvature; 235 on the posterior wall; 95 at the pylorus; 69 on the anterior wall; 50 at the cardia; 29 at the fundus, and 27 on the greater curvature. It is worth noting that, although peptic ulcer of the stomach is most frequently found on the lesser curvature and the posterior wall, peptic jejunal ulcer nearly always comes after an anterior operation.

The site of the secondary ulcer in Tiegel's series was as follows: In 10 instances it was found near the gastric stoma; in 1 near the opening of the enteroenterostomy; in 10 cases it was in the jejunum, separated one to seven centimeters from the gastroenterostomy opening; in 3 cases the ulcers were multiple, in 7 there were also ulcers in the stomach.

[1] Kocher. Verhandl. d. Deutsch. Gesellsch. für Chir., Bd. XXXI, 1902, S. 103.
[2] Hahn. *Ibid.*, Bd. XXVIII, 1899, S. 74, and Bd. XXXI, 1902, S. 114.
[3] Virchow. Virch. Arch., Bd. 5, S. 362.
[4] Welch. Pepper's System of Medicine, 1885, Vol. II, p. 482.

It is probable that the jejunum is more open to circulatory disturbances when attached by the anterior than by the posterior method, in view of the statistics of 18 anterior against 5 posterior. Tiegel suggests that the circulation may be impeded in several ways. The coil which passes in front of the transverse colon may be too short and, therefore, be subjected to tension from stretching, or else kinks may occur in the mesentery itself and cut off a part of the blood supply. Another factor contributing to restrict the blood supply of the jejunal coil is *arteriosclerosis*. In one of Steinthal's cases marked atheroma was associated with a slight kinking of the mesentery. Direct *injury to the mucous membrane* has been mentioned as a cause of peptic jejunal ulcer. This may occur at the time of operation, from manipulation of the instruments, or it may come later from scratching the mucous membrane with hard particles of food.

In comparing the human with the two reported experimental cases it will be seen that analogous results have been obtained. In the cases of Watts (dog), and of the author (cat), the primary operations were both anterior gastroenterostomies. It will be remembered that, as far as position goes, the anterior wall of the quadruped stomach corresponds to the greater curvature of human beings, and that the posterior gastroenterostomy in man is the nearest approach to the anterior gastroenterostomy in animals.[1] However, the position of the four-footed animal allows the stomach to press downward upon the anastomosis, and this might lead to circulatory disturbance by pressure, kinking, or stretching, as in the human being.

Pathology.—Tiegel states that growth of a peptic ulcer of the jejunum is a process wholly similar to the formation of a peptic ulcer of the stomach. There is first an effusion of blood into the mucous membrane, usually of small extent, followed later by death and digestion of the affected area. As Steinthal has observed, the loss of substance extending only through the mucous membrane, at first, finally reaches down through all the layers of the intestinal wall. In cases which take a very acute course the shape of the ulcer is round, and the walls smooth and steep. The more slowly advancing lesions, on the contrary, attack the layers separately, so that the walls of the ulcer are terraced. Finally, a secondary

[1] Cannon and Blake. Annals of Surgery, May, 1905.

inflammatory reaction is set up which obscures more or less the characteristics of the original lesion. The ulcer walls become infiltrated, tumefied, and firm; and the shape of the ulcer irregular. In cases of longer duration adhesions form with neighboring organs, into which the ulcer finally perforates. According to Lennander[1] (quoted by Tiegel), no pain-perceiving nerves are situated in the stomach or intestine. Diseases of these organs produce no pain unless the process has reached the peritoneum. For this reason there may be a perforation of the ulcer without previous symptoms.

The drawings shown are from a specimen taken from the second series. The animal was an undersized female cat. The operation was an anterior

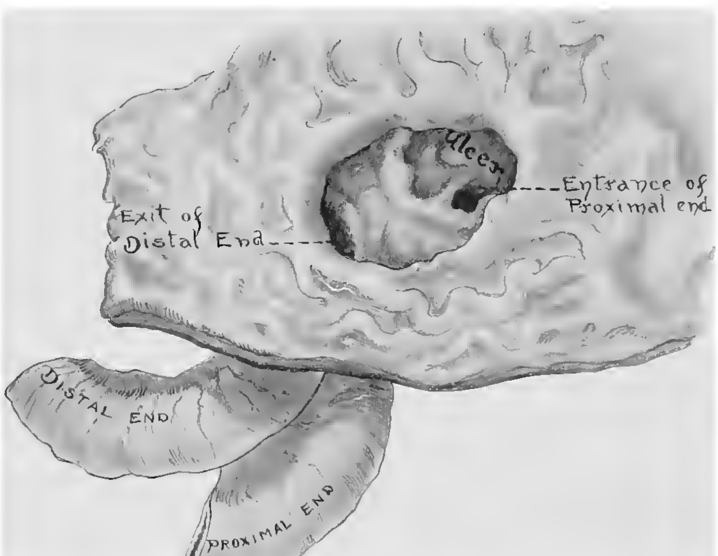


FIG. 11.—PEPTIC ULCER OF THE JEJUNUM OF A CAT, PROVING FATAL TEN MONTHS AFTER ANTERIOR GASTROENTEROSTOMY.

By looking down through the stoma, the jejunum can be seen. Note entrance and exit of proximal and distal coils, respectively. About entrance of proximal coil is a large punched-out ulcer covering half of the patch of jejunum. This ulcer extends out beneath the line of suture.

gastroenterostomy done with clamps, the incision being four centimeters in length; linen thread was used for both layers of sutures. The animal remained in good health for eight months after the operation, after which it began to fail rapidly, with symptoms of pain, vomiting, and cramps of the abdominal muscles. The cat died of marasmus ten months after operation.

[1] Lennander. Cent. für Chir., 1901, S. 209.

Fig. 11 is a drawing from the gross specimen. The stomach has been opened and its walls cut away up to within a short distance of the anastomosis, showing the jejunal patch blocking the stoma in the anterior gastric wall. An examination of the portion of the jejunum underlying the gastric opening shows it to be the seat of an extensive punched-out ulceration about the entrance of the proximal coil. The ulceration has extended laterally into the gastrointestinal suture line, thus undermining the latter's edge for a distance of one-eighth to one-half inch. It is important to observe that, although the ulcer was situated exactly at the suture line, no contraction of the stoma had resulted, the opening of four centimeters originally made at the operation being found the same at death.

The microscopical section (Fig. 12) explains well the condition of affairs. Apparently the mucous membrane of the stomach, adjacent to the ulcer, is normal, since no thickening or excoriation is to be seen. The sides of the ulcer are punched out sharply, while at the junction of the sides with the base a deep excavation extends out beneath the edges of the ulcer. In the base of the ulcer little of the jejunal tissue can be found, its normal structure being replaced by a thin layer of granulation tissue. Within the granulation tissue are embedded a few muscle-fibers, but it is evident that the ulcer had completely cut through all coats of the jejunum. The activity of the repair in responding to the irritation of the lesion had resulted in the formation of a provisional base for the ulcer, thus preventing immediate perforation. It is probable that this provisional base would not have controlled the advance of the ulceration had the animal survived the marasmus.

REPAIR FOLLOWING THE USE OF THE MURPHY BUTTON.

It is hardly necessary to explain the application of the well-known Murphy button. It suffices to say that anastomosis is accomplished by fastening a button half into each open intestinal end. The button is so constructed that, by snapping the halves together, the peritoneal surfaces of the circumference of the bowels are brought nicely together, and held until firm adhesions have bound the ends one to the other. The portions of bowel, which are jammed between the halves of the button, slough, thus freeing the instrument, which passes out per anum.

Barbat[1] has paid attention to this technic and has published a detailed

[1] Barbat, J. H. Journal Am. Med. Asso., July 15, 1899.

account of the method in which intestinal union takes place. He found that the muscularis and the mucosa were pushed completely out of the way when the button was made fast, so that the peritoneum and the submucosa were the only coats left within the bite of the button (Fig. 13.) It is difficult to understand how this could happen at once, although the lighter structure of the mucous membrane would probably soon succumb to the pressure exerted from the inside. It is also entirely possible that the muscular fibers may be ruptured by the crushing of the instrument, thus permitting them to retract out of the grasp of the button. Barbat found that the peritoneum was so infolded that there was no uncovered surface at any point. The junction of the mesentery with the bowel uncovers a narrow area where the peritoneum is reflected to pass around the gut. Of course this point could not be covered by peritoneum under any circumstances. After a period of from one to three weeks, possibly much longer, the pressure of the button causes death and sloughing of the bowel edges within its clasp; thus the button is liberated, and is allowed to pass on. Sections taken at this time show that healing has occurred between the two peritoneal and the two submucous layers. The mucosa is lacking over the line of approximation for a variable distance, usually not more than one-twentieth of an inch. The internal ulcer, therefore, is much narrower than that which results from other methods of anastomosis, and, although it might have some advantage in hastening the closure of the gap, yet it is evident that the reason for the condition is the extreme thinness of the line of union. The pushing aside of the muscular layers occasionally makes a narrow scar which, presumably, is not so firmly organized as if it had the additional strength of the muscular layers. Barbat states that regeneration of the mucous membrane begins four to six weeks later. If this observation has been correctly understood by me, the time required is from four to six times as long as that used by the suture in layers.

The final result is a good one: each grows up to the scar, and attaches itself to the corresponding layer on the other side. In Barbat's specimens there was no reproduction of the muscularis mucosæ (Figs. 14, 15, and 16.)

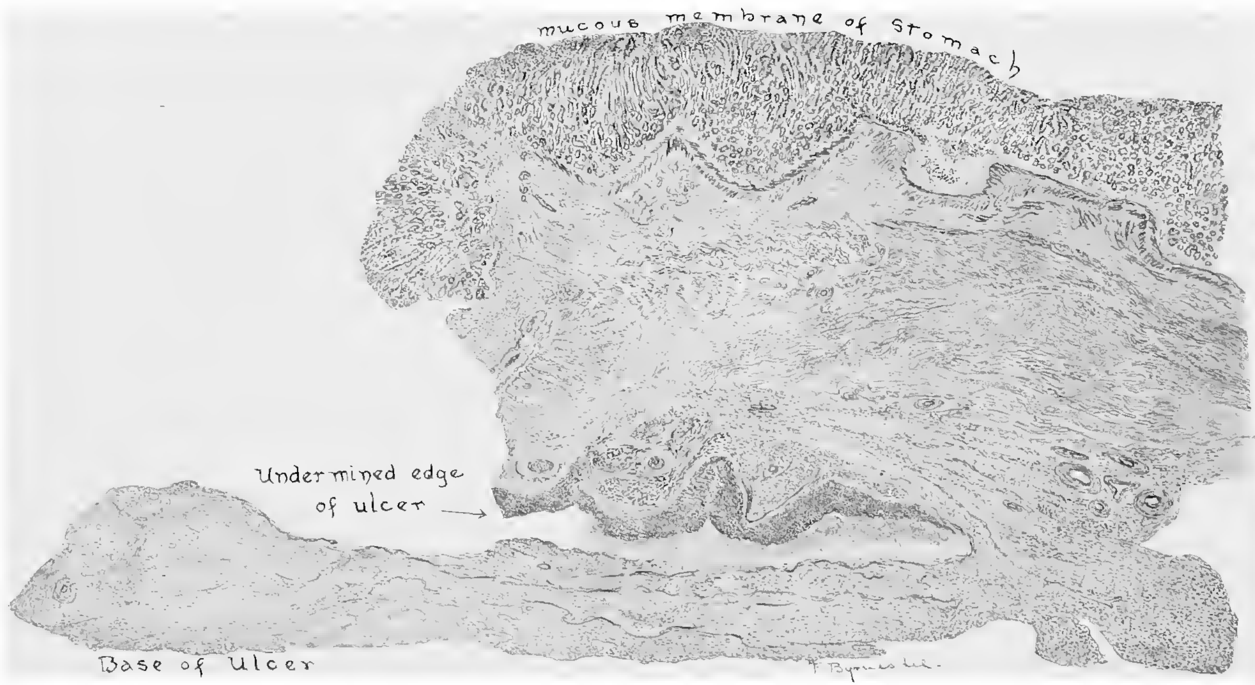


FIG. 12.—CROSS SECTION OF PEPTIC ULCER OF THE JEJUNUM.

This shows well the punched-out character of the ulcer. On the right the mucosa of the stomach is intact up to the point where it is abruptly cut out by the ulcer. Note that the side wall of the ulcer is clean-cut, while the junction of the side wall with the base is marked by a deep excavation which extends far out to the right. The base of the ulcer is made up of granulation tissue, with muscle-fibers interspersed.

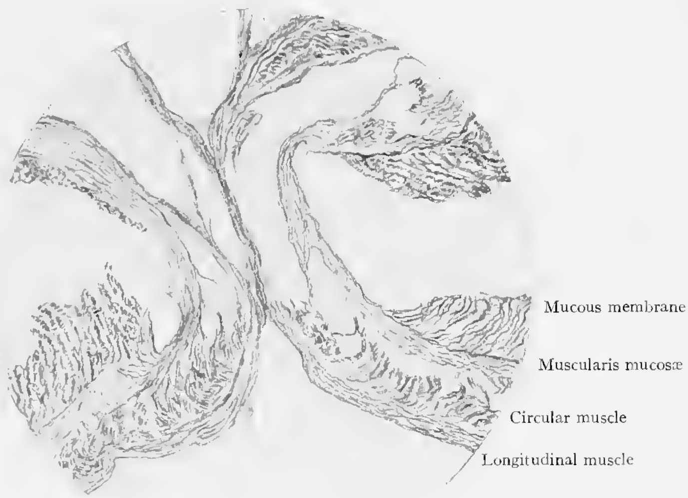


FIG. 13.—REPAIR FOLLOWING THE USE OF THE MURPHY BUTTON, THREE DAYS. Shows mucous and muscularis pressed away at point of union. (Drawn from Barbat.)

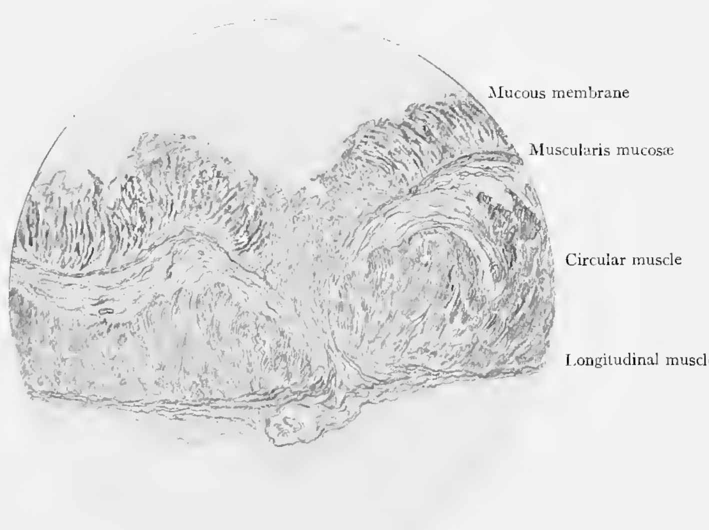


FIG. 14.—REPAIR FOLLOWING THE USE OF THE MURPHY BUTTON, THIRTY-SIX DAYS. Firm healing of wound, no repair of muscularis mucosæ. (Drawn from Barbat.)

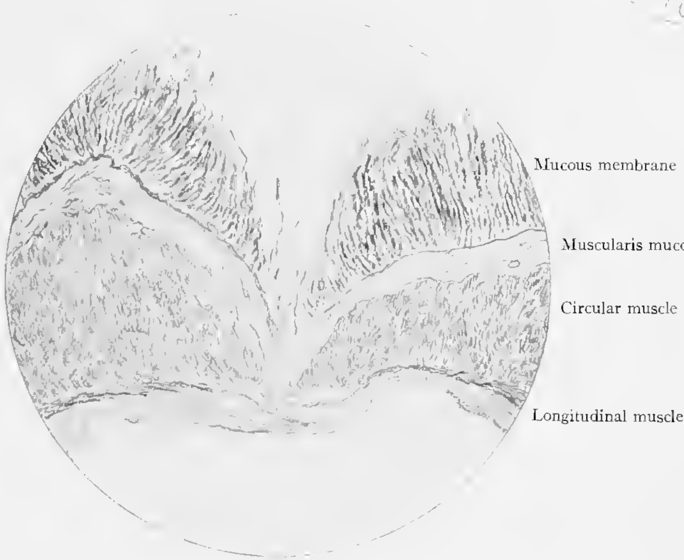


FIG. 15.—REPAIR FOLLOWING THE USE OF MURPHY BUTTON, FORTY-TWO DAYS.
Thin scar; mucosa attached to what originally was the external callus. Muscle-fibers separated. No repair of muscularis mucosæ. (Drawn from Barbat.)

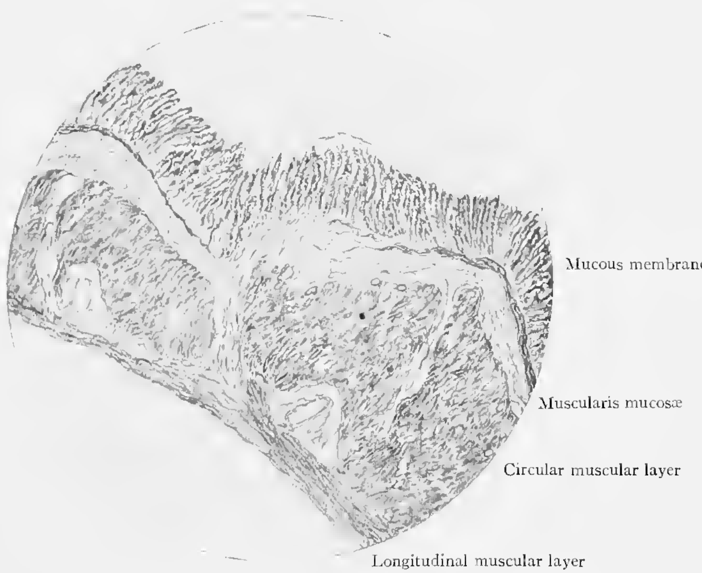


FIG. 16.—REPAIR FOLLOWING THE USE OF MURPHY BUTTON, SIXTY-THREE DAYS.
Mucous membrane intact; muscularis mucosæ not repaired; muscular tissue still separated by thick scar. (Drawn from Barbat.)

Fig. 17.—Section Across the Mass of Tissue Enclosed within the Loop of the Elastic Ligature, Five Days' Duration.

Showing pressure necrosis due to the elastic ligature. (Murphy.)

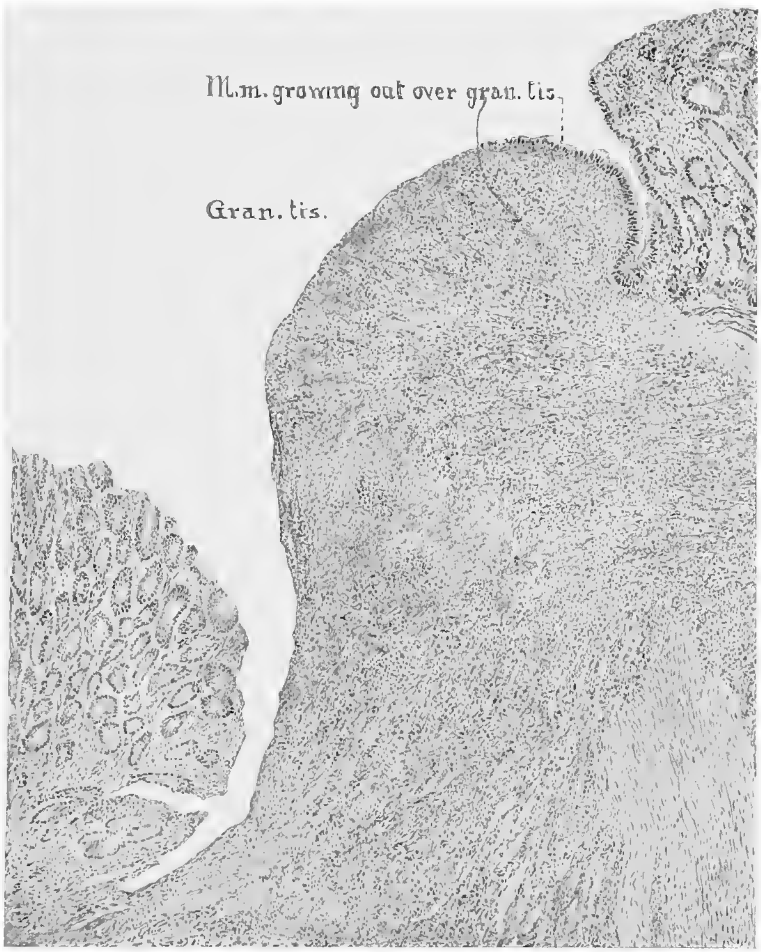


FIG. 18.—SECTION AT RIGHT ANGLES TO THE LINE OF UNION OF THE STOMACH AND JEJUNUM, TWELVE DAYS' DURATION.

Showing an area of granulation tissue between the two viscera with the mucous membrane growing over it from either margin. (Murphy.)

FIG. 19.—SECTION AT RIGHT ANGLES TO THE LINE OF UNION OF THE STOMACH AND JEJUNUM, THIRTY DAYS' DURATION.

Showing fairly dense scar tissue completely covered by newly formed mucous membrane. A, Point at which submucosa of jejunum has been cut through; B, point at which submucosa of stomach has been cut through. (Murphy.)

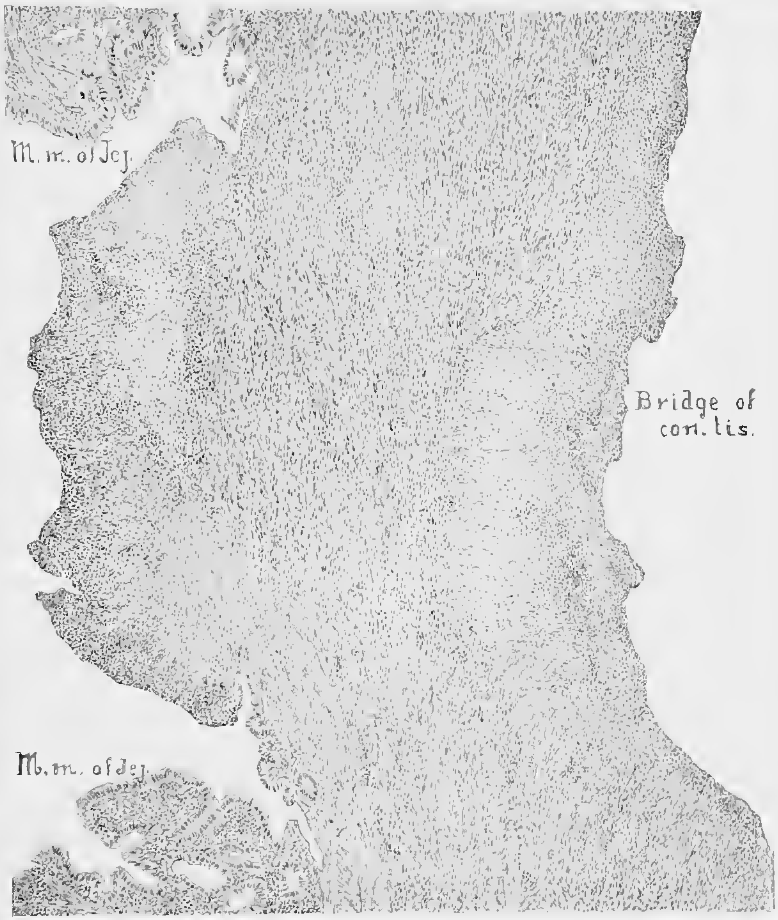


FIG. 20.—SECTION ACROSS AN ADHESION, SEVEN DAYS' DURATION, WHICH HAD FORMED BETWEEN THE EDGES OF THE JEJUNUM AFTER THE ELASTIC LIGATURE HAD CUT OUT. (Murphy.)

REPAIR FOLLOWING THE USE OF THE ELASTIC LIGATURE.

The technic employed in forming an anastomosis by means of the elastic ligature is described in Chapter IV. In brief this technic consists in sewing together two adjoining hollow viscera with a single rubber suture, which penetrates into the lumina, and is placed in the long axes of the organs. When the suture is drawn tight and tied the walls of the bowel or of the stomach, which it includes, will be constricted. A continued constriction of the tissues grasped by the rubber will result in necrosis and sloughing, thus establishing a permanent artificial opening between the two organs. When the rubber ligature has cut itself free it drops into the intestine and passes on. As an additional precaution against leakage the peritoneal surfaces of the attached organs are sewed together around the rubber ligature, so that cutting through of the ligature will be devoid of danger.

The repair of the intestine after the introduction of the elastic ligature may be stated as follows:

The tissues included within the grasp of the ligature at once become anemic, and rapidly degenerate (Fig. 17). The muscle-fibers lose their staining properties and pressure necrosis with actual rupture of the muscle ensues. As the degeneration of the ligatured area progresses, a reaction is noted at the line of demarcation between the living and the dead tissues, characterized by an infiltration with leucocytes, small round cells, and serum. After four or five days the tissues have been changed into a slough, which becomes loosened, and is finally cast off. The conditions now present are exactly similar to those noted when the bowels are opened at once with a knife, and sewed together with two layers,—*i. e.*, the edges of the opening are sealed and held in place by the plastic exudate during the process of healing of the internal ulcer.

The covering of the internal ulcer with mucous membrane requires from seven to ten days. Fig. 18 shows the internal ulcer resulting from the cutting out of the ligature. In this case the mucous membrane may be seen closing over the ulcer twelve days after operation. It is of interest to compare this specimen with Fig. 6, which shows almost the same stage of healing twelve days after an anastomosis with the segmented ring. Fig. 19 illustrates the end result where the granulation tissue at the line of anastomo-

sis has been changed into a scar, and the suture-margin of the hole completely covered with mucous membrane.

During the act of the cutting out of the ligature it is possible for different points on the surface of the internal ulcer to be drawn together. If opposite points on the edges of the opening are held in apposition sufficiently long, adhesion will take place between the two raw surfaces, and the bridge thus formed will divide the stoma into two parts, neither of which will be large enough to serve the purpose of the operation.

Fig. 20 is a section through a bridge of tissue caused in the manner just described. It is formed wholly of granulation tissue.

The observations concerning repair following the use of the elastic ligature are drawn from a study of the specimens and drawings kindly loaned me for the purpose by Dr. F. T. Murphy.[1]

[1] Murphy, F. T. Boston Med. and Surg. Journal, January 28, 1904.

CHAPTER II.

SUTURE MATERIALS, NEEDLES, TYING KNOTS, SUTURES, AND CLAMPS.

SUTURE MATERIALS.

To obtain the best results in gastrointestinal surgery, both soluble and insoluble suture material must be used. It is customary to employ soluble material for stitches which enter the bowel lumen, while the use of insoluble material is reserved for the outer seromuscular layer. No fixed rule, however, can be given, for surgeons have successfully used soluble sutures for the seromuscular, and insoluble for the penetrating stitches.

The inner layer of stitches is only a temporary affair, the purposes of which are to approximate the cut edges accurately, to control bleeding, and to reinforce the outer layer. Therefore, there are no advantages in retaining these stitches after the first few days, when the adhesions and the granulation tissue have already bound the cut bowel ends tightly together.

While the small details of the process of repair inside the bowel may be disregarded, so long as the serous coats are carefully brought together, it must be remembered that every stitch which enters the bowel lumen is subjected to a chance of infection from the organisms within the intestine.

Theoretically, this is a serious danger; but, practically, very few accidents result from this cause. Leakage of a suture may usually be attributed to one of three causes:

(1) Inaccurate approximation of the peritoneum between the stitches.

(2) Infection from escape of intestinal contents from the opened gut.

(3) Bruising of the cut edges by rough handling during the operation.

If these three errors of technic are avoided, the occasional penetration of the bowel lumen may be disregarded.

On the whole, catgut fills most of the requirements for the inside stitches. Either plain or chromicized gut can be used, but the latter is preferable, merely because its greater strength allows it to be used in small sizes.

Chromic gut will resist the disintegrating action of the gastric juice for from one to three weeks, and the portions of the stitch not thus exposed may remain intact for several weeks longer.

The whole theory and practice of intestinal surgery is founded upon the fact that two peritoneal surfaces, adjoining an intestinal wound, adhere to each other when held for a certain time in apposition. Twenty-four hours at least are necessary to seal the joint in this manner. To hold the tissues during this critical period, and until the process of repair is thoroughly established, suture material is required which is wholly unchangeable by local conditions. Although catgut is not absorbed in twenty-four hours, swelling from absorption of water, and subsequent loosening of the knot under the influence of distention or of active peristalsis of the bowels, is not uncommon.

The best examples of insoluble material are silk and Pagenstecher's celloidin linen thread. Silk is still preferred by some for the seromuscular stitches; but it makes by no means an ideal suture as it always acts badly in the neighborhood of an infected focus. The infection of any insoluble stitch is unfortunate, but the loose texture of silk offers a refuge to pyogenic cocci, so that the stitch itself becomes a source of contagion.

In comparison with silk, celloidin linen thread has numerous advantages. The hard surface of thread thus prepared is resistant to the penetration of bacteria, and, once thoroughly sterilized by boiling, can be buried in the abdomen with relatively little danger.

The ease experienced in handling celloidin thread is accounted for by the fact that it does not lose its hard consistency when soaked with water, and this prevents it from sticking to the fingers or to the sheets. Cutting out of a celloidin stitch is a rare occurence, for the irregularities of the individual strands are converted into a smooth surface by the celloidin. This is a very useful quality, though it applies more generally to the small sizes, for in the larger sizes the thread is somewhat rough.

Celloidin thread acts well inside the stomach. The portions exposed to the action of the gastric juice will be disintegrated in about six weeks; the remainder of the stitch will gradually loosen and fray out, until, at the end of six months, only the deepest portions will be left where they may remain indefinitely, encapsulated within the tissues. During the process of erosion by the gastric juice, salts may be deposited upon the thread,

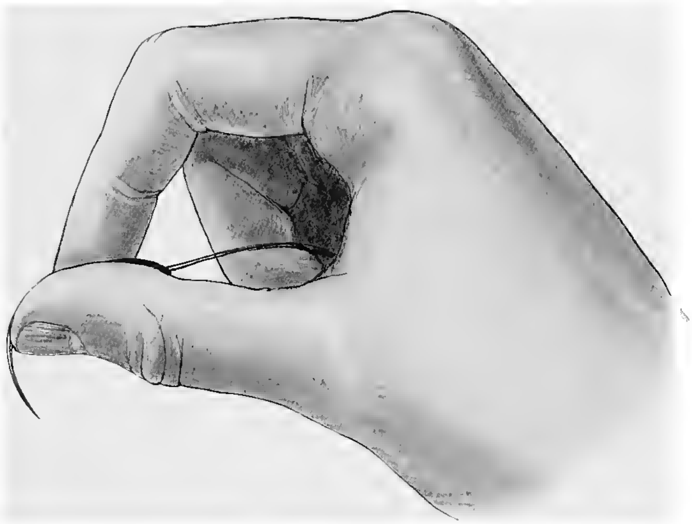


FIG. 21.—METHOD OF HOLDING CURVED NEEDLE, POINT TOWARD OPERATOR.

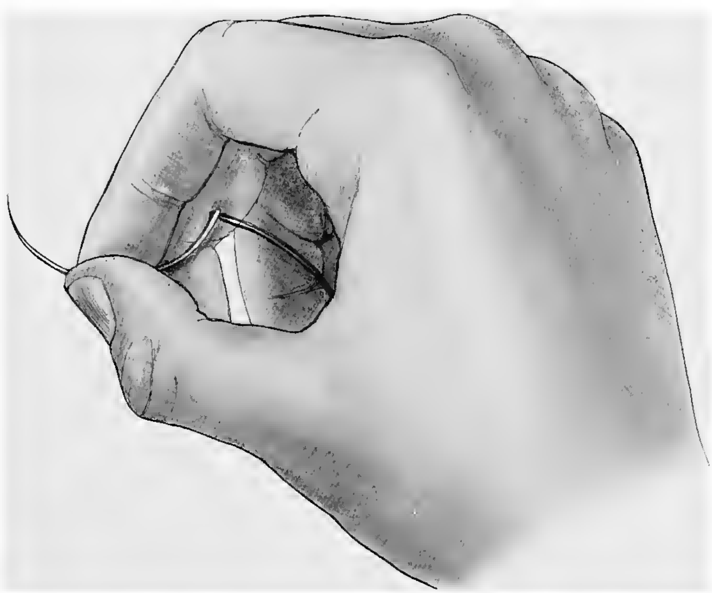


FIG. 22.—METHOD OF HOLDING CURVED NEEDLE, POINT AWAY FROM OPERATOR.

forming concretions which may remain in place for weeks and attain a diameter of one-eighth inch. This deposit of salts may temporarily retard the further destruction of the thread, but it has no other effect upon the repair of the wound.

After repeated boiling, celloidin thread becomes friable and splits longitudinally, but at least three sterilizations can be done with safety. The above observations are drawn from a series of animal experiments.

NEEDLES.

A large, round-pointed, straight needle held in the fingers makes sewing very easy, although many surgeons prefer a curved needle and a needle-holder. The needle-holder, however, prevents the operator from knowing exactly how deep he is penetrating into the bowel wall because the delicacy of touch essential for this demands contact between fingers and needle. A straight needle will reach practically any point, but, if occasionally found to be awkward, the difficult stitches may be taken with a curved needle.

FIG. 23.—MILLINER'S NEEDLE NO. 3—ACTUAL SIZE.

Moynihan uses a needle with so full a curve that its manipulation is easy without a holder (Figs 23, 24). In sewing with a curved needle the point may be held either towards or away from the operator, as circumstances require. When the point is towards the operator, the thumb is firmly fixed in the bend of the needle, while held in place by the counter-pressure of the first finger. The thread may be caught in the palm, by the last three fingers, and held on the stretch as an additional safeguard against slipping of the needle. If the point is away from the operator, a reverse position is taken, the first two fingers being wedged into the curve of the needle, while the thumb presses firmly from the opposite side (Figs. 21, 22).

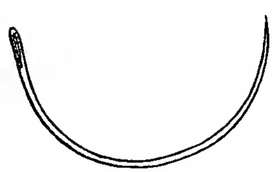


FIG. 24.—MOYNIHAN'S CURVED NEEDLE, AS MODIFIED BY SCUDDER—ACTUAL SIZE.

On the whole, the straight needle offers such an increase in speed and accuracy of penetration that it is usually to be preferred. If a straight needle is chosen, a No. 3 milliner's, threaded with fine celloidin thread (No.

1) is a serviceable combination. No. 0 chromic catgut threads easily into both the No. 3 milliner's and the Moynihan curved needles.

TYING KNOTS.

There are several methods of tying square knots. One good method should be learned and used exclusively. A satisfactory system, described below, was shown me by Dr. C. B. Porter.

(1) The long end of the tie is held in the palm of the left hand, the short end between the thumb and finger of the right hand (Fig. 25).

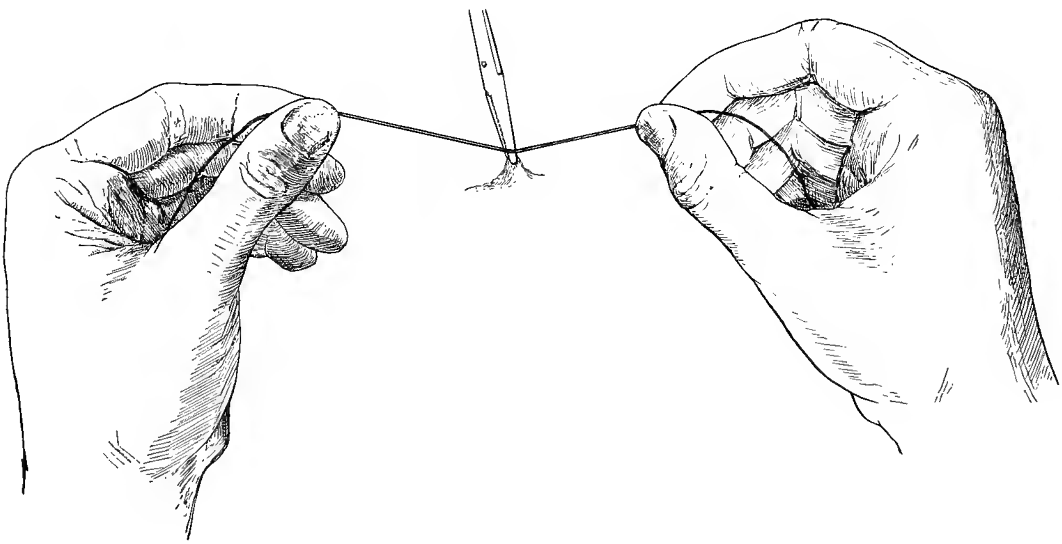


FIG. 25.—The long end of the tie is held in the palm of the left hand, the short end between the thumb and finger of the right hand.

(2) The short end, in the right hand, is passed half way around the hemostatic forceps, where it is caught by the forefinger of the left (Fig. 26).

(3) The short end is brought around to the front again by a turn of the wrist, and passed over the long end (Fig. 27).

(4) The short end is again grasped by the right to steady it while the two sides of the loop are held apart by the middle finger of the right and the forefinger of the left hands, the left forefinger catching the loop at the point of crossing of the two arms (Fig. 28).

(5) The short end is carried through the loop from beneath upwards,

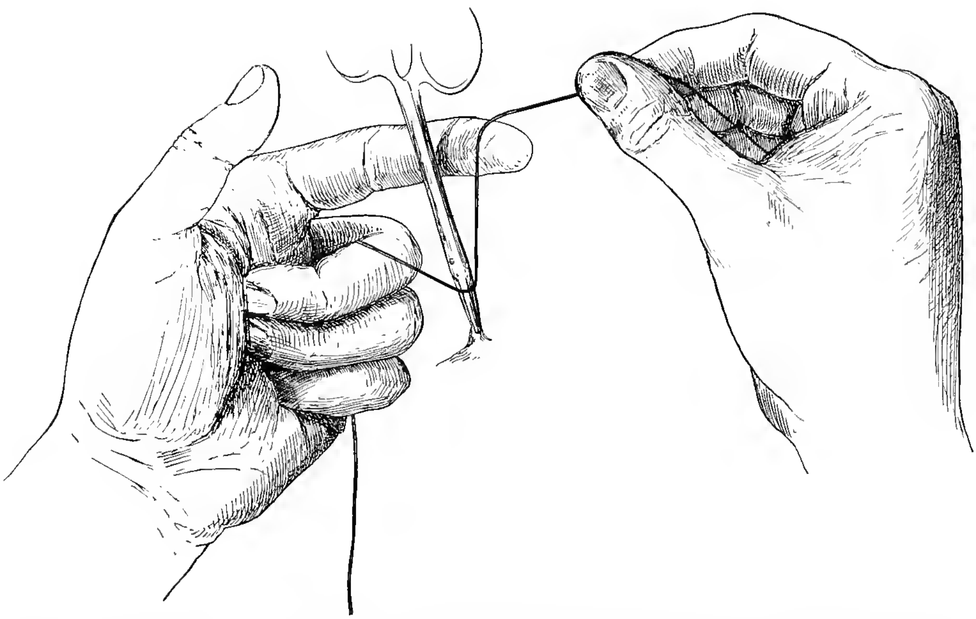


FIG. 26.—The short end in the right hand is passed half way around the artery forceps, where it is caught by the forefinger of the left hand.

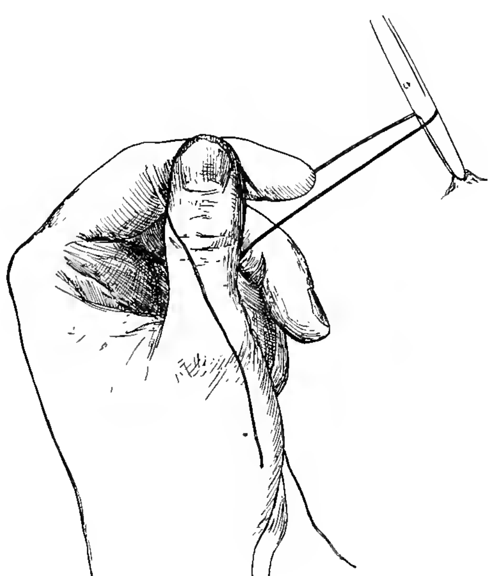


FIG. 27.—The short end is brought around to the front again by a turn of the wrist and passed over the long end.

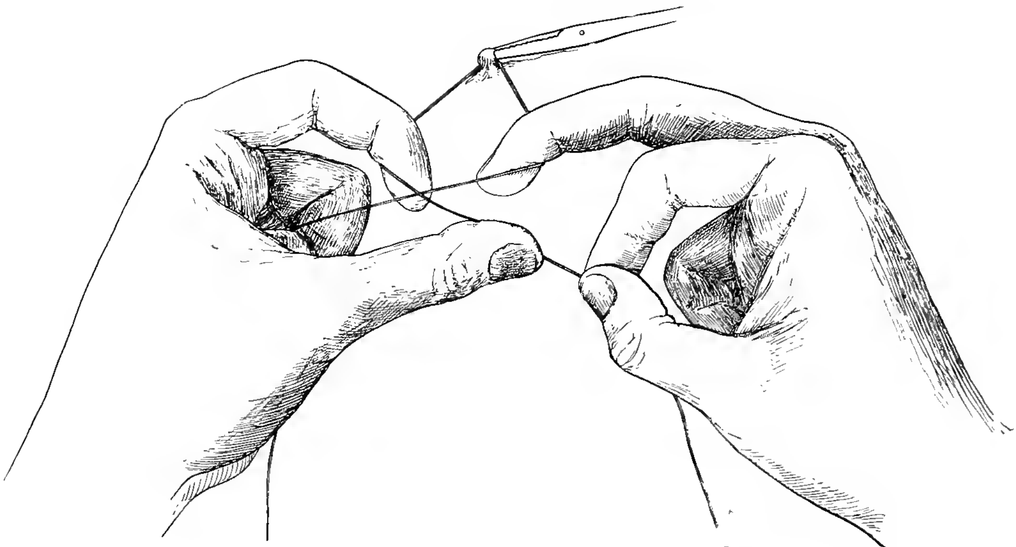


FIG. 28.—The short end (S) is again grasped by the right hand to steady it, while the two sides of the loop are held apart by the middle finger of the right hand and the forefinger of the left hand, the left forefinger catching the loop at the point of crossing of the two arms.

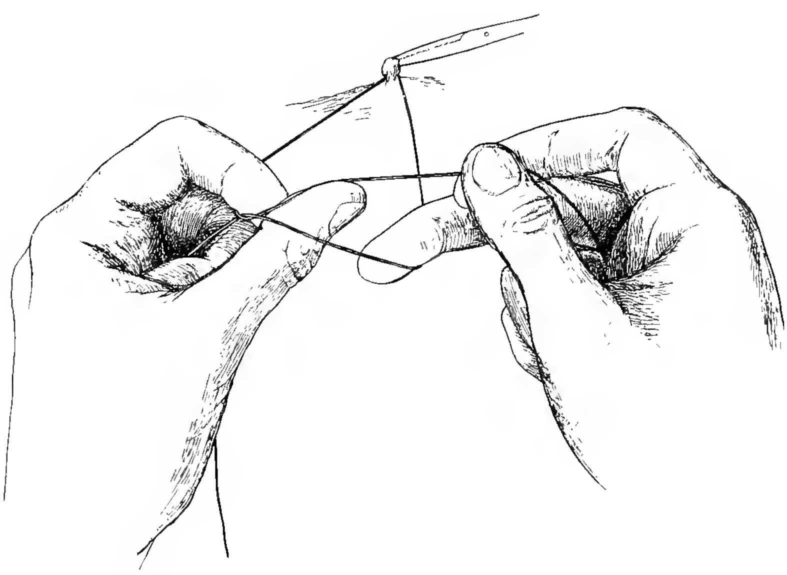


FIG. 29.—The short end is carried through the loop from beneath upwards, using the thumb as a shuttle, and the short end again picked up by the right hand.

using the thumb as a shuttle, and the short end again picked up by the right hand (Fig. 29).

(6) The tissues are allowed to relax by removing the artery forceps, as the first half of the knot is tied over the index fingers. No pull should be

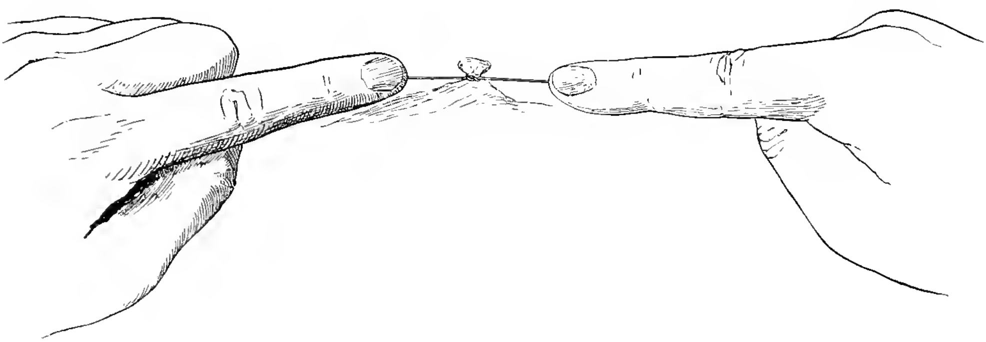


FIG. 30.—The tissues are allowed to relax by removing the hemostatic forceps, and the first half of the knot is tied over the ends of the index fingers. No pull should be exerted upon the first half of the knot while the second half is being tied, else slipping will occur.

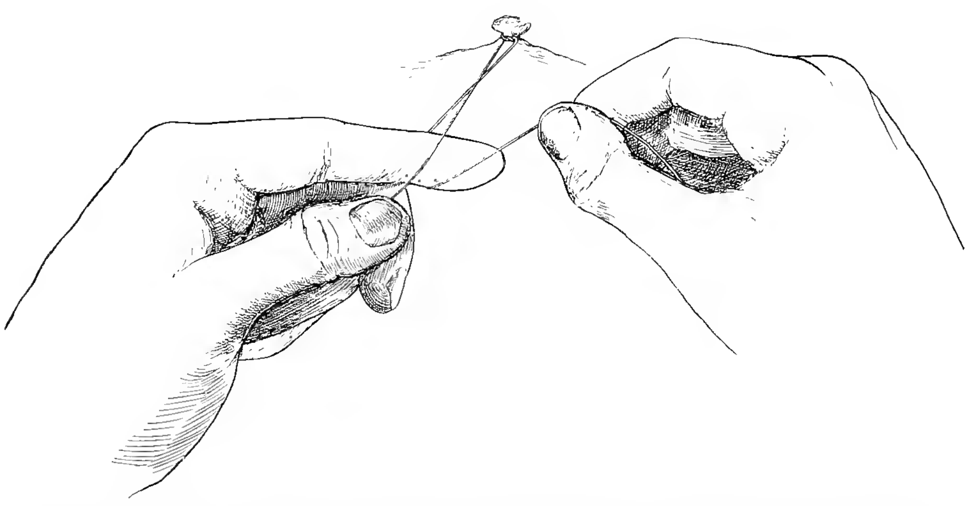


FIG. 31.—The second half-knot is exactly the reverse of the first. The short end is carried around the left forefinger from right to left at a point where it will cross the long end of the tie, the palm being turned down at the same time.

exerted upon the first half of the knot while the second half is being tied, else slipping will occur (Fig. 30).

(7) The second half of the knot is exactly the reverse of the first. The short end is carried around the left forefinger from right to left at a point

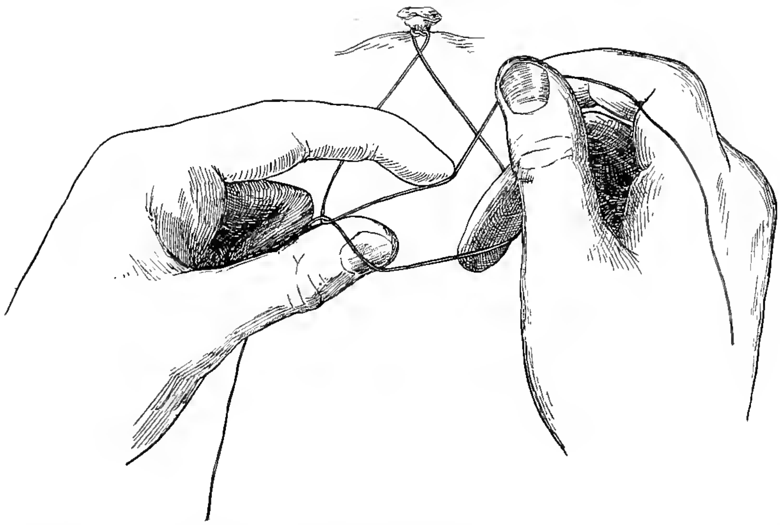


FIG. 32.—The loop is kept open by the right middle finger, and the left thumb quickly substituted for the left forefinger, since the latter is to act as the shuttle. The short end is, finally, carried through the loop by the left forefinger, from above downwards and caught by the right hand.

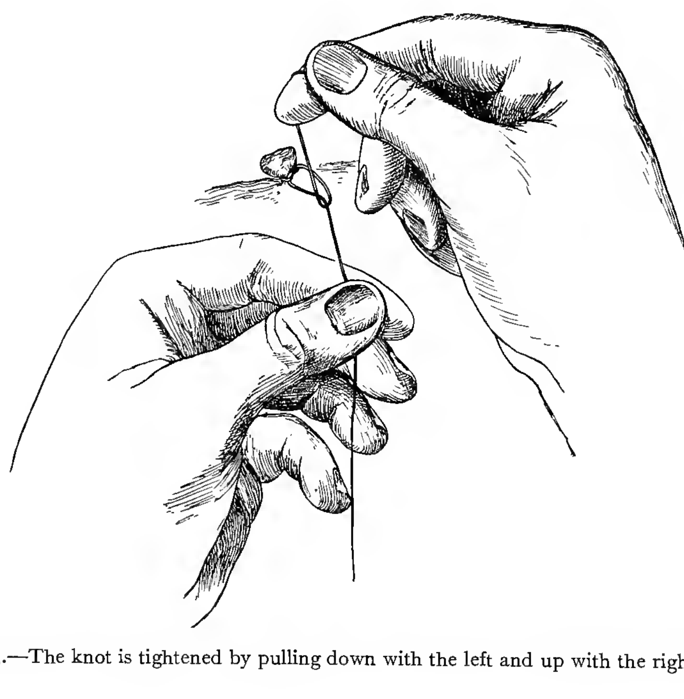


FIG. 33.—The knot is tightened by pulling down with the left and up with the right hand.

where it will cross the long end of the tie, the left palm being turned downward at the same time (Fig. 31).

(8) The loop is kept open by the right middle finger and the left forefinger, since the latter is to act as the shuttle (Fig. 32). The short end is finally carried through the loop by the left forefinger from above downward and caught by the right hand.

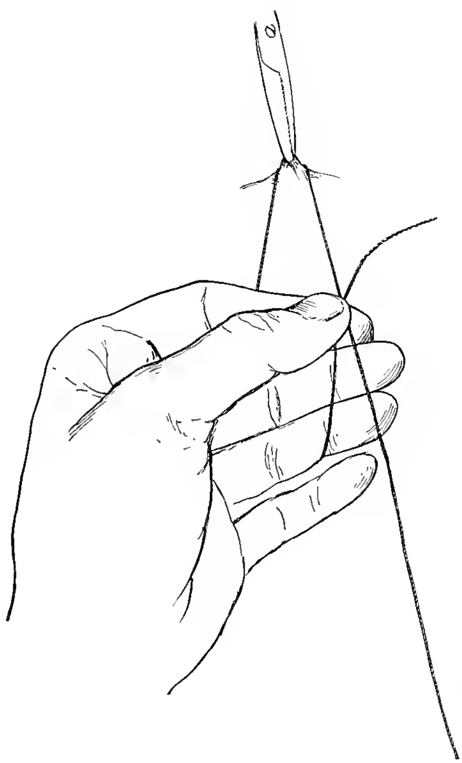


Fig. 34.—Richardson's One-hand Knot. The tie has been passed around the snap, the thumb ready for the first tie.

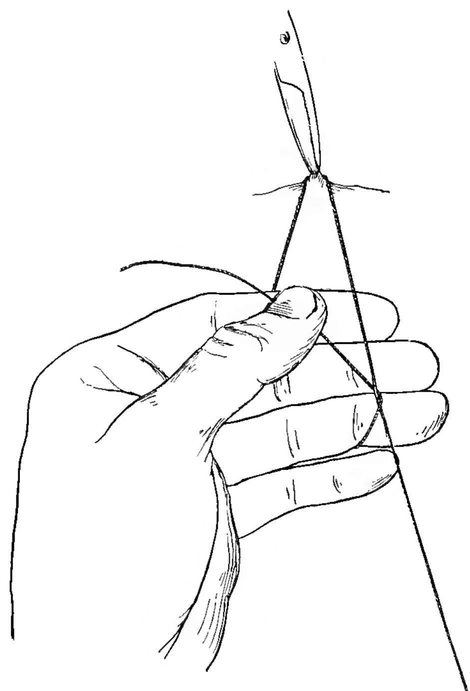


Fig. 35.—Richardson's One-hand Knot. Drawing the first turn taut.

(9) The knot is tightened by pulling down with the left, and up with the right hand (Fig. 33).

Richardson's One-hand Knot.[1]—This method is especially adapted for tying the first knot of a continuous suture. With it the end of the thread can be made fast with great rapidity. It requires rather skilful fingers to tie the knot every time without a miss, for the least slipping of the thread

[1] M. H. Richardson, not published.

will hinder the shuttle action of the fingers. It is common to see several attempts made in each loop before the whole knot is completed. The steps taken in tying Richardson's one-hand knot look confusing both on paper and in the cuts, but the manœuvre itself is easily understood and simply done. When the knot is used to tie a bleeding vessel the short end of

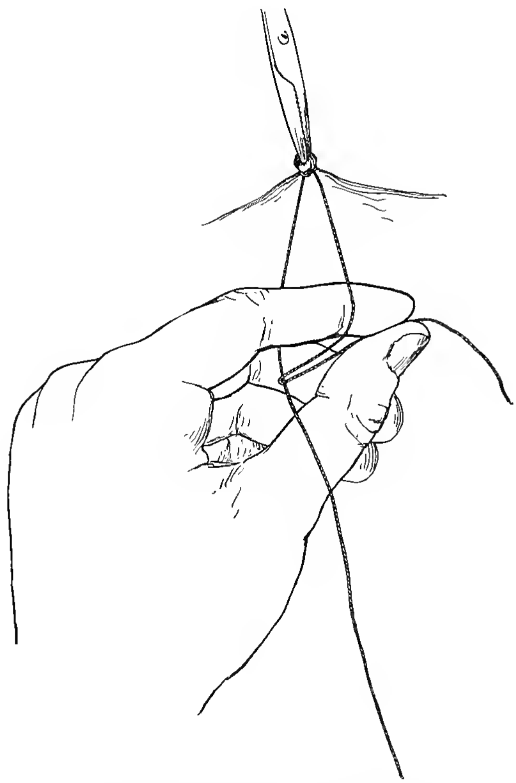


FIG. 36.—RICHARDSON'S ONE-HAND KNOT.
Tying the second half of the knot.

the ligature is passed around the snap from right to left in the same manner as described for the first step of the preceding knot, where the end is seized by the left hand. The tie is made with two motions:

(1) The short end is carried over the long end, from left to right, the left thumb pushing the short end around and under the point of crossing from below upward until it appears between the two arms of the loop as

they are held apart by the left index finger (Fig. 34). The first half-knot is then set, and, if a snap has been used, it is removed (Fig. 35).

(2) The second half of the knot is the reverse of the first. The short end is drawn across the long end from right to left and carried under the point of crossing, using the thumb as a shuttle and the forefinger to hold apart the loop, just as was done in the first step (Fig. 36). This technic will produce a square knot every time if the short end is pointed to the right in

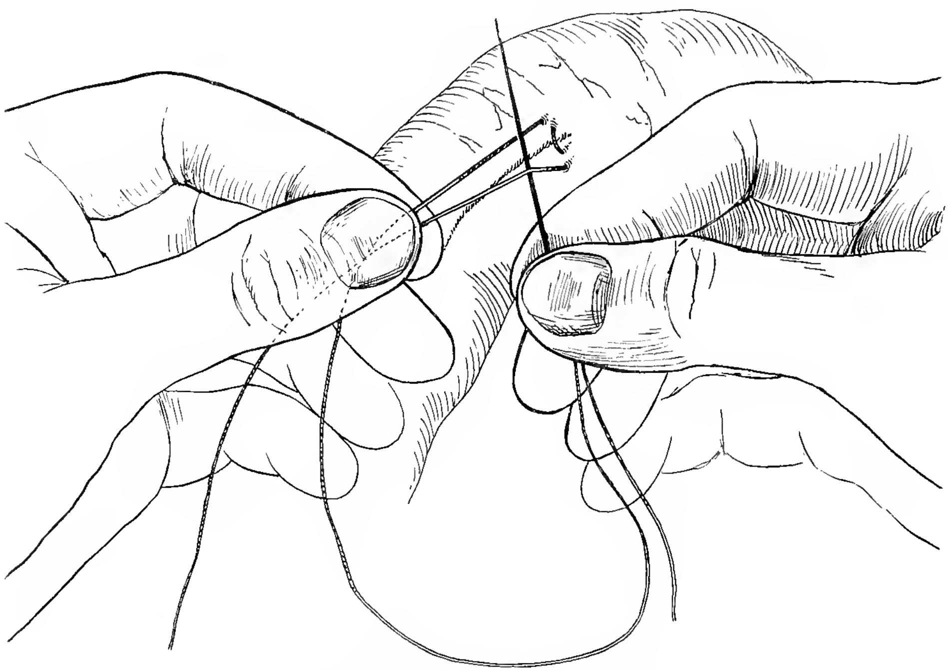


Fig. 37.—Seamstress Knot, First Step.
Left hand draws both ends of stitch to left, thus forming a loop. Needle enters loop from below upward and to right.

the first half, and to the left in the second half. These steps may be reversed in order if desired.

Seamstress Knot.—This knot is used by Dr. Oviatt, of Wisconsin, through whom it came to the author's attention. Its rapidity and accuracy are gained by substituting the needle for the finger in carrying the end of the tie through the loop. It is assumed here that the stitch has been taken in a direction away from the surgeon, thus leaving the short end on the proximal and the long end on the distal side of the wound.

(1) The long end with the needle is first drawn back across the wound

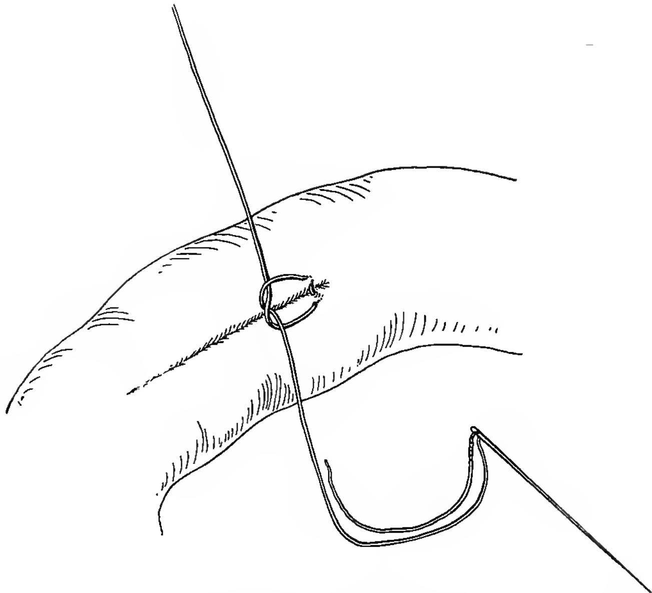


FIG. 38.—SEAMSTRESS KNOT, SECOND STEP.

First half of knot tied as follows: Short end pulled away from operator with left hand; long, or needle end, drawn toward operator with right.

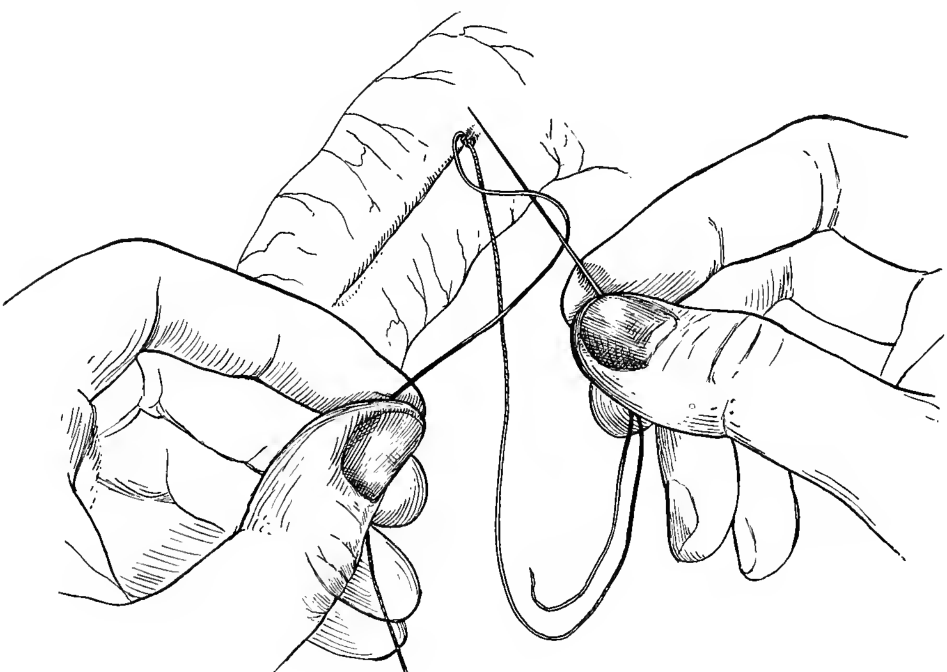


FIG. 39.—SEAMSTRESS KNOT, THIRD STEP.

Last half of knot. The short thread in left hand is twisted to right to form a loop. Needle enters loop from above to right. The second half of knot is tied by pulling away with long or needle end, and toward operator with short end.

toward the operator. The point of crossing of the two ends is seized between the left thumb and forefinger and held up while the needle is pushed under the arch made by the thread from left to right (Fig. 37).

(2) The first half of the knot is set by pulling downward on the long or needle end with the right hand, and upward with the short end in the left hand (Fig. 38).

(3) To tie the second half of the knot the short end in the left hand is carried back across the wound toward the surgeon and slightly twisted between the fingers so that a good loop is furnished. Through this loop the needle passes from left to right (Fig. 39). The knot is set by pulling upward on the long end in the right and downward on the short end in the left hand.

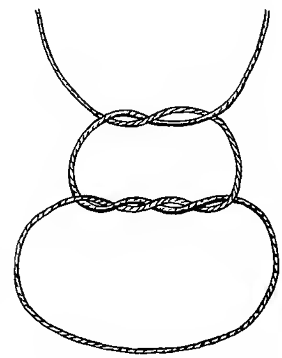


FIG. 40.—A SURGEON'S KNOT AS IT IS USUALLY TIED.

Note that first half of knot has two turns, while the second half has but one.

Surgeon's knot is made in exactly the same manner as other square knots are made, except that two turns are taken instead of one in the first half (Fig. 40). It is employed to prevent the slipping of the first half while the second half of the knot is being tied. This is a dangerous knot to use in intestinal work because the double turn in the first half of the knot prevents the knot from slipping easily in either direction, thus adding an obstacle to setting the knot which is not compensated by its other qualities. So much traction is exerted upon the stitch holes in tying the surgeon's knot that the stitch frequently cuts out during the manœuvre.

SPECIAL TECHNIC OF SUTURES.

The sutures employed for intestinal anastomosis may be divided into three classes:

(1) Those that aim to approximate the peritoneal coats and penetrate only through the muscularis mucosæ (seromuscular):

(1) The Cushing right-angle continuous.

(2) The Lembert continuous, [interrupted].

(3) The mattress (Halsted), (Gould).

(4) The Purse-string.

(2) Those that aim to approximate the cut edges without, necessarily, bringing together the peritoneal coats.

(1) The through-and-through continuous, or glover's.

(2) The buttonhole (Heister).

(3) Those that penetrate all coats and approximate the peritoneum,—*i. e.*, penetrating mattress:

(1) Maunsell's mesenteric stitch.

(2) Connell's mattress anastomosis.

(3) Seromuscular-penetrating mattress, (Jobert).

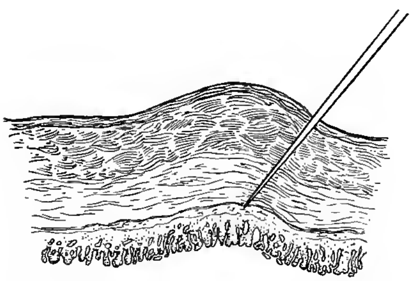


FIG. 41.—THE SEROMUSCULAR STITCH. Shows proper angle and depth of penetration of seromuscular stitch.

The Seromuscular Stitch.—The muscularis mucosæ is the only portion of the bowel wall that offers a firm anchorage for a stitch, and the recognition of this tough elastic layer is essential to the security of the joint. A very good way to become familiar with the peculiar resistance offered to the needle, by the muscularis mucosæ, is by practising upon a piece of stretched rubber dam; the sensations of resistance and penetration are practically identical. The needle enters the bowel wall at a very obtuse angle (Fig. 41), until

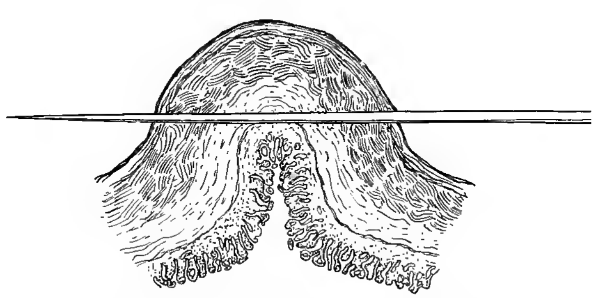


FIG. 42.—THE SEROMUSCULAR STITCH. Shows method of lifting up fold of bowel before pushing the needle completely through.

it just pierces the muscularis mucosæ, when the point is firmly lifted, and with it the fold of bowel wall which it has impaled. The needle is

then pushed through the opposite side of the fold (Fig. 42) and the thread drawn tight. An accurate approximation of the serous surfaces is assisted by always picking up folds of equal length. The needle should never be pushed through until the fold is lifted on the needle, as just described.

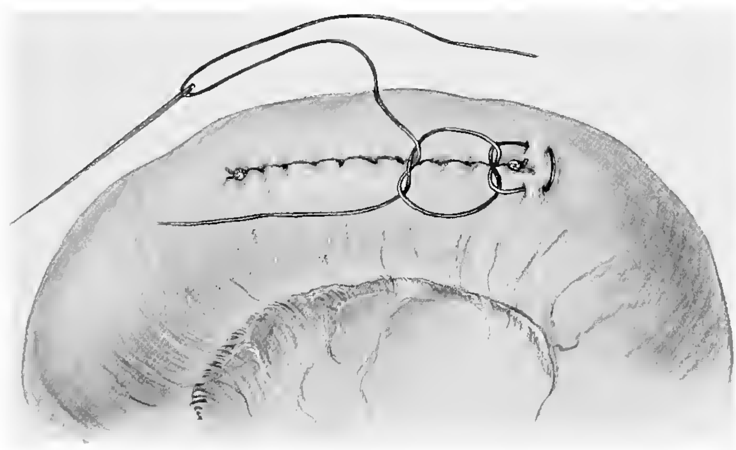


FIG. 43.—CUSHING RIGHT-ANGLE CONTINUOUS STITCH.
The first layer of through-and-through stitches has been placed. Note method of introducing the first stitch and knot of the Cushing suture.

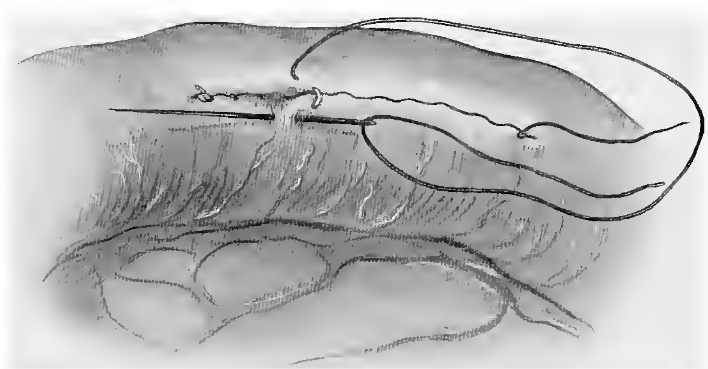


FIG. 44.—CUSHING RIGHT-ANGLE CONTINUOUS STITCH.
Note wave-like suture line. Stitch half completed.

The Cushing Right-angle Continuous Stitch.[1]—To begin this stitch, the needle pierces the bowel parallel to the wound, but in a direction opposite to that of the intended suture (Fig. 43), thence crossing the wound at a

[1] Cushing, H. W. Med. and Surg. Reports, Boston City Hospital, 1889

10

right angle it pierces the bowel again exactly opposite, and parallel to the first half of the stitch, this time in the direction of the intended suture. This places the knot conveniently for continuing the suture. The subsequent stitches are taken parallel with the wound, about one-eighth inch apart. The

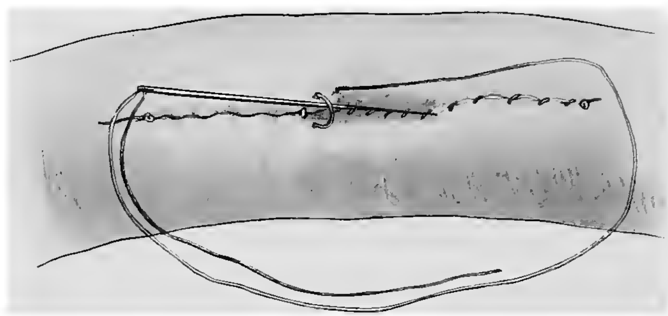


FIG. 45.—CUSHING RIGHT-ANGLE CONTINUOUS STITCH.
Note method of depressing the first layer of stitches with needle. To tighten the stitch the thread is drawn out exactly in the direction of the last stitch taken, parallel to the wound.

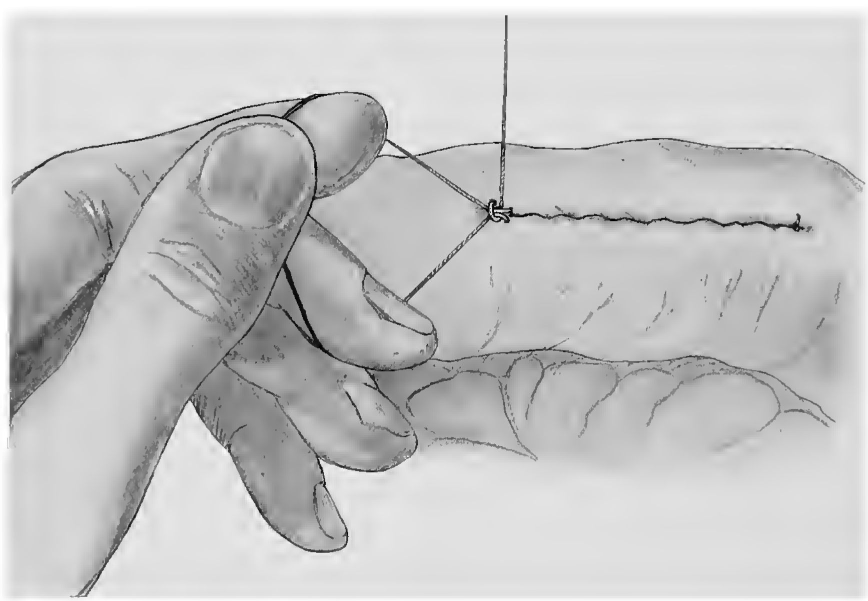


FIG. 46.—CUSHING RIGHT-ANGLE CONTINUOUS STITCH.
Suture completed. Note method of tying last knot by drawing tight both arms of loop with fingers.

thread crosses the wound at right angles, and, leaving about one-eighth inch margin from the cut edge, again enters the peritoneum parallel to the wound, at a point opposite the hole of exit of the last stitch (Fig. 44). After

each stitch the thread should be drawn tight, and, to prevent cutting out, the pull should be made parallel to the wound, exactly in the direction of the last stitch taken. In order to bring the serous surfaces closely together when the stitch is tightened, the first layer of through-and-through sutures should be pushed down with the needle while the thread is pulled with the other hand (Fig. 45). When this continuous stitch has been properly placed and tightened, the thread, which is completely buried by the invaginated serous surfaces, travels parallel to the wound in nearly a straight line, and a wave-like suture line results which is caused by the dovetailing of the individual needle bites.

After the last stitch has been placed the thread is picked up at the point of its last crossing, between the exit of the next to the last and the entrance of the last stitch. The thread is pulled out here in a loop, long enough for convenient tying, and knotted with the single thread which has just emerged from the hole of exit of the last stitch. Both arms of the loop must be separately pulled tight to set the knot (Fig. 46).

The Lembert Stitch[1] is used both for continuous and for interrupted

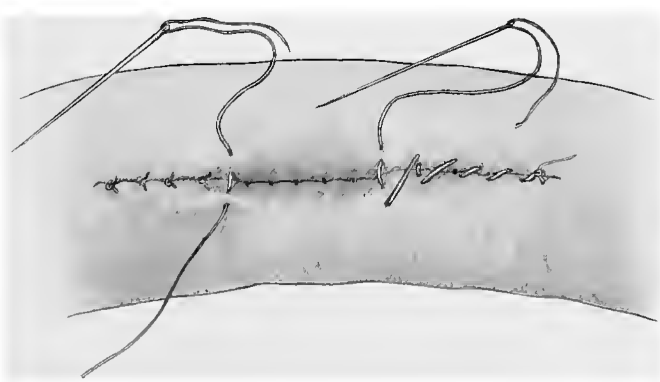


FIG. 47.—THE LEMBERT STITCH.

The interrupted stitch is shown on the left, the continuous stitch on the right. The apparent irregularity in the continuous stitch is due to its not yet having been pulled tight.

sutures. The stitches are placed at a right angle to the line of the wound, about one-eighth inch from the cut peritoneal edge (Fig. 47), and when tied, roll in the edges, and perfectly approximate the serous surfaces. If the suture is to be a continuous one[2] the manœuvres are exactly the

[1] Lembert. Repertoire Générale d'Anatomie et de Physiologie Pathologique, T. II, p. 3, 1826.

[2] Dupuytren, Diffenbach, Lehrbuch der Chirurgie, Bd. III, S. 458.

same as observed for the interrupted stitch, although, instead of tying separately, all the stitches are connected with each other. After placing the first stitch, the thread is carried diagonally across the wound to the new stitch, which enters the bowel a short distance further along, parallel with the first. The last knot is tied in the same manner as done in the right-angle continuous stitch of Cushing. Figs. 48 and 49 show the stitches in cross section.

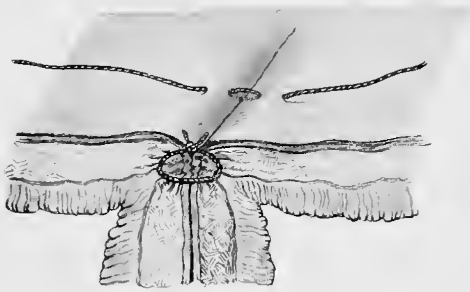


FIG. 48.—LEMBERT INTERRUPTED STITCH, WITH CROSS SECTION.

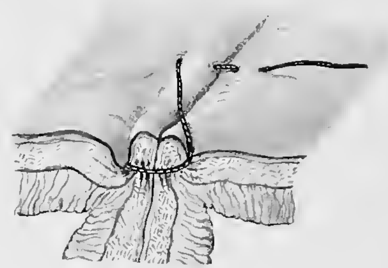


FIG. 49.—LEMBERT CONTINUOUS STITCH WITH CROSS SECTION.

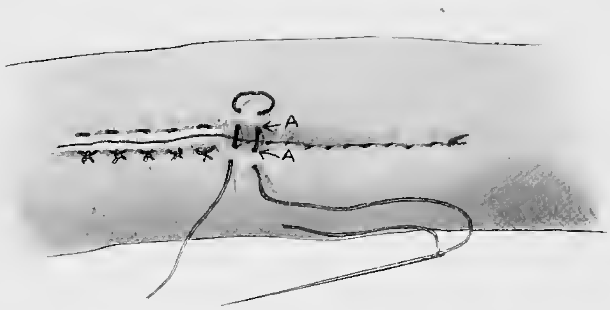


FIG. 50.—HALSTED MATTRESS STITCH.
A drawn to A.

The Mattress Stitch.—Halsted[1] has described an interrupted mattress stitch for approximating the serous coats (Fig. 50). This suture consists of two parallel Lembert stitches connected on one side of the wound by a loop, leaving the two ends free on the opposite side. When these ends are tied, the lips of the wound are drawn together and a strong, accurate joint thus obtained. This stitch has the disadvantage of not rolling in the peritoneum, as well as limiting the extent to which the inversion of the cut edge may be carried.

[1] Halsted, W. S. Johns Hopkins Hospital Bulletin, January 1891.

Author's[1] reversed mattress stitch is a modification of the Halsted mattress. The aim of this stitch is actually to obtain the inverting effect of the Lembert stitch combined with the added strength of the mattress stitch. This result is obtained by reversing the loop so that it lies close to the wound.

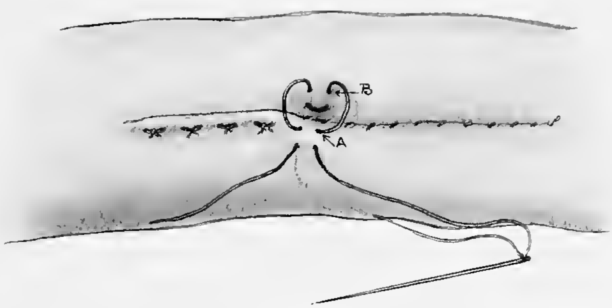


Fig. 51.—Author's Mattress Stitch.

Note that the loop is reversed. This results in the rolling in of the peritoneum on the side of the loop—B drawn to A.

The stitch can be remembered by recalling the fact that the first two bites are taken towards the wound, the second two bites away from the wound (Fig. 51).

Figs. 52 and 53 are cross sections which show well the results given by the two mattress stitches.

The reversed mattress stitch has one of its chief uses in burying the stump of an appendix. The preliminary steps of the operation are not of importance here. The meso-appendix is ligated in the usual way, thus freeing the appendix so that it can be held forward. A reversed mattress stitch is introduced on the cæcum, the arms of the stitch being placed so that the base of the appendix lies between them. A strip of gauze should be passed about the appendix to protect the mattress stitch from being infected while the resection is being done. After cleaning the stump of the appendix, the ends of the mattress stitch are drawn tight and tied, and the stump of the appendix disappears without tucking (Figs. 54 and 55).

Fig. 52.—Halsted Mattress Stitch, with Cross Section.

[1] Gould, A. H. Boston Medical and Surgical Journal, December 29, 1904.

The Purse-string.—This suture is useful in several situations: (1) In closing the end of a cut intestine to form a blind sac; (2) as a preliminary step to the introduction of mechanical devices; (3) whenever it is necessary to invaginate an isolated portion of the peritoneum,—*e. g.*, to close a denuded area, or to bury the stump of an appendix. It is used both in end-to-end and in lateral anastomoses.

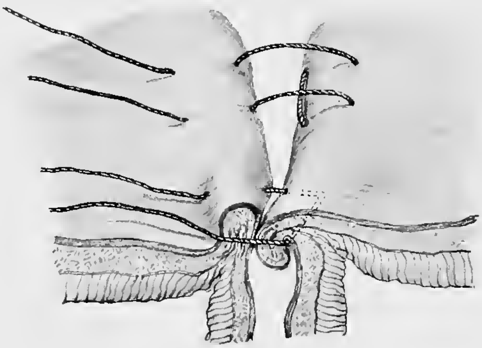
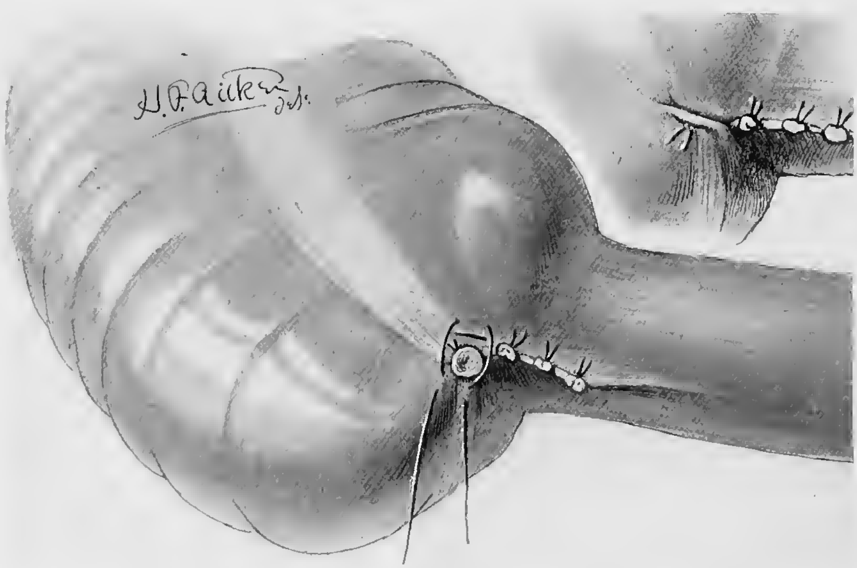


FIG. 53.—AUTHOR'S MATTRESS STITCH, WITH CROSS SECTION.

Two methods are quite generally in use for applying the purse-string, which differ from each other in their relation to the cut edges of the opening which they are to close:



FIGS. 54, 55.—USE OF REVERSED MATTRESS STITCH FOR BURYING STUMP OF APPENDIX.

(1) The first method[1] is shown in outline and in cross section, respectively, by Figs. 56 and 57. It consists of a series of interrupted seromuscular

[1] Doyen. Chirurgen Congress Verhandl., 1898, p. 200.

stitches placed in continuity. This suture, though located about one-eighth inch from the cut edge of the gut, does not cross the edge, as is done by the next method. For this reason it is possible to place the stitch before opening the bowel,—a decided advantage in providing against sepsis. The needle enters the anti-mesenteric border of the bowel and circles the gut, or, in lateral anastomosis, the proposed line of incision, with frequent bites. When it reaches the mesenteric border, it crosses under the mesenteric attachment, appearing on the other side, after which it passes up to the point of beginning on the anti-mesenteric edge. A half-knot is tied in the two ends in order to allow the suture to be made fast as soon as possible after opening the intestine. Fig. 58 illustrates, somewhat diagrammatically, the use of the purse-string for lateral anastomosis[1]. The dotted line which appears on the cut edges of the incision indicates the path of the stitch through the tissues; it is, in fact, exactly like other seromuscular stitches. In placing the purse-string for lateral anastomosis it should be held in mind that the incision into the side of the intestine will be a straight line, so that the purse-string must not inclose a circular area, but must be made in two halves, each consisting of several bites forming a straight line parallel to the future incision. These halves are connected at one end by a loop,

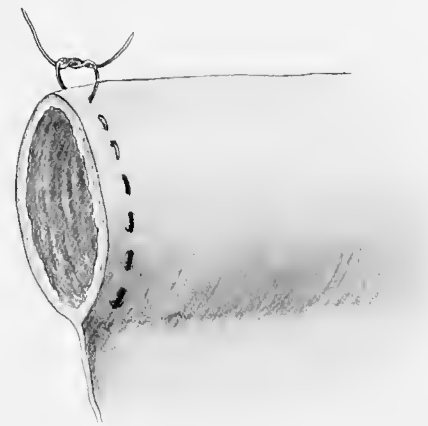


FIG. 56.—THE PURSE-STRING SUTURE.
A series of interrupted stitches placed in continuity. It circles the bowel about one-eighth inch from the cut edge.

FIG. 57.—PURSE-STRING STITCH, CROSS SECTION.

[1] Murphy, J. B. New York Medical Record, Vol. XLII, 1892, December 10, p. 667.

as shown in Fig. 58, and some care will be needed to avoid cutting the thread when the opening is made.

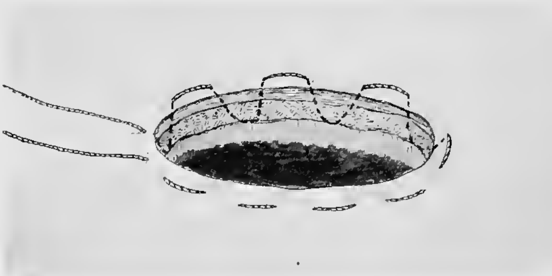


FIG. 58.—PURSE-STRING SUTURE FOR LATERAL ANASTOMOSIS.
Dotted lines on cut edge show depth of penetration of stitches; not an actual cross section.

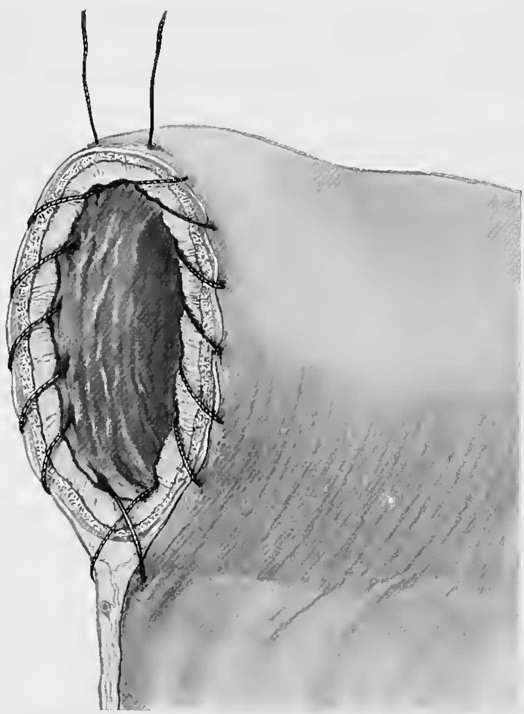


FIG. 59.—MURPHY'S PURSE-STRING SUTURE, USED FOR BUTTON.
A continuous suture around the cut edge of the bowel, including the mesentery. (Redrawn from Bickham.)

(2) The second method is used by Murphy[2] in the introduction of his button. In this instance the suture begins also at the anti-mesenteric bor-

[2] Murphy, J. B. *Ibid.*, p. 672.

der, but is placed after the bowel has been opened. It pierces directly through all the bowel coats and travels around the cut edges over and over, from without inwards. When the mesenteric attachment is reached the stitch skips diagonally across the triangular section of mesenteric fat that marks the junction of the bowel with its mesentery, and picks up a portion of the mesentery at that point. The suture finally completes the circuit of the second half of the circumference, ending at the free border, beside the first hole of entrance of the needle (Fig. 59). This method of placing a purse-string is very effective mechanically, but the constant handling of the open bowel soils the fingers and adds unnecessarily to the danger of infection.

The Through-and-through Continuous Suture (Glover's)[1].—Formerly it was considered necessary to sew the bowels together by layers before approximating the serous surfaces. By this arrangement, one layer of stitches was used for the mucous membrane and another for the muscle, and a third for the peritoneum. As shown in the study of the process of repair, the healing of the cut edges forming the internal ulcer is not accelerated by an inner layer of stitches, but rather retarded owing to the necessity of absorbing these stitches before the ends can wholly heal over. While it is not necessary to sew each layer separately, an inner layer of stitches has sufficient advantages to offset this slight delay in the process of repair. As mentioned later in considering the end-to-end anastomosis, they serve to control hemorrhage from the cut edges, and reinforce the seromuscular stitches while the exudation is taking place which is to seal the joint.

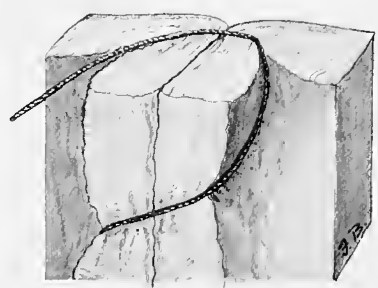


FIG. 60.—GLOVER'S CONTINUOUS STITCH, WITH CROSS SECTION.

The glover's is a continuous over-and-over suture. The stitch may start from the inside, or from the outside, according to circumstances; but its chief feature lies in its penetration of all the coats, including the peritoneal. It passes from without inwards, on one side, and from within outwards on the other side (Fig. 60). After penetrating both edges at a right angle, it

[1] Salicetto, Guglielmo di. Vulnus Intestini, sutura pellionum, Chirurgia, Venet., 1470, p. 376.

crosses diagonally over the cut edges and again penetrates the opposite edge. In piercing the bowel wall, the needle should always be placed at a right angle both to the long axis and to the cut edge of the bowel.

The Buttonhole Suture (Heister[1]).—This is a modification of the

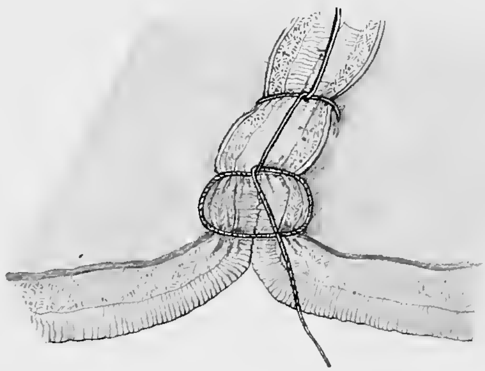


FIG. 61.—THE BUTTONHOLE STITCH, WITH CROSS SECTION.

glover's stitch and is used to supply the place of the latter. The needle penetrates the bowel edges exactly as in the glover's; but, before crossing, a half-hitch is taken in the loop. This stitch is useful to approximate wounds where the tissues cannot relax, such as the skin, where hemorrhage

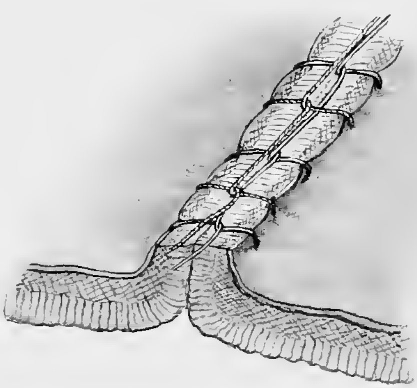


FIG. 62.—BUTTONHOLE STITCH DOUBLED. (W. J. Mayo.)

is not important; but it is unreliable as an inner suture for intestinal wounds (unless reinforced, as done by W. J. Mayo). It converts the continuous stitch into a series of interrupted stitches, none of which are tied, so that the hemorrhage from the spaces between loops is not controlled. If the

[1] Heister, Lorenz. Chirurgie, Nurnberg, 1763, Chapter VI.

stitch is applied while clamps are in place, there is nothing to prevent the flexible intestinal walls from relaxing when the clamps are removed, thus loosening the whole stitch. If the stitch is placed without clamps, to be effective it must be drawn so tight that the cut edges are drawn into irregular puckerings which render difficult the placing of the seromuscular stitch (Fig. 61).

The Through-and-through Mattress Suture (Connell)[1] is used for end-to-end and for lateral anastomosis. This stitch starts inside the lumen of one bowel, about one-eighth inch from the cut edge. It pierces all the bowel coats, and, crossing outside the wound, at a right angle, pierces all the coats of the second cut bowel from without inward, at a spot opposite and symmetrical to the needle hole in the first cut edge, thus entering the second bowel lumen. The needle now turns and escapes from the bowel by again piercing all layers, from within outward, about one-eighth inch to one side of the hole where it entered the lumen. It then crosses the bowel edges parallel to the first half of the stitch, and finally penetrating all coats of the first bowel, reenters the lumen. The two ends are tied, as they lie side by side, on the same lip of the wound, and the serous surfaces thus brought into firm apposition. A complete anastomosis may be made in this manner which does not require further reinforcing. These stitches must be placed close together because there is nothing to control the bleeding from the intervening cut edge (Fig. 63).

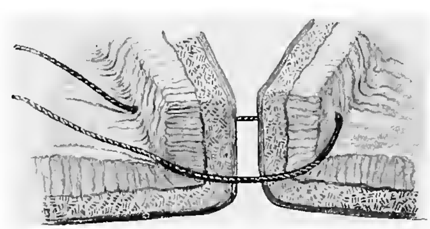


Fig. 63.—Penetrating Mattress Stitch, Cross Section of One-half of Stitch.

The Mattress Mesenteric Stitch (Maunsell).[2]—The mattress stitch has its most useful application in establishing a firm joint at the mesenteric border. The stitch is placed exactly in the same manner as the one last described. Since the mesenteric attachment is immediately below the point where the needle will emerge in piercing all coats, the needle enters

[1] Connell, M. E. Med. Record, 1892, Vol. XLII, p. 335. Connell, F. G. Philadelphia Monthly Med. Journal, Vol. I, 1899.

[2] Maunsell. Lancet, 1892, Vol. II, p. 473; American Jour. Med. Sci., March, 1892.

the triangular mesenteric space for about one-eighth inch (Fig. 64), then, turning to one side, pierces the peritoneum. Figs. 65 and 66 show the space for the mesenteric attachment of the intestine. In entering the second bowel, the reverse plan is necessary, the needle first piercing the triangular space of the mesenteric attachment before it enters the bowel. Once inside, the needle turns and passes out again, repeating the steps, and reenters the first bowel, where it is tied. This stitch should be employed in every form of end-to-end anastomosis, except the Murphy button.

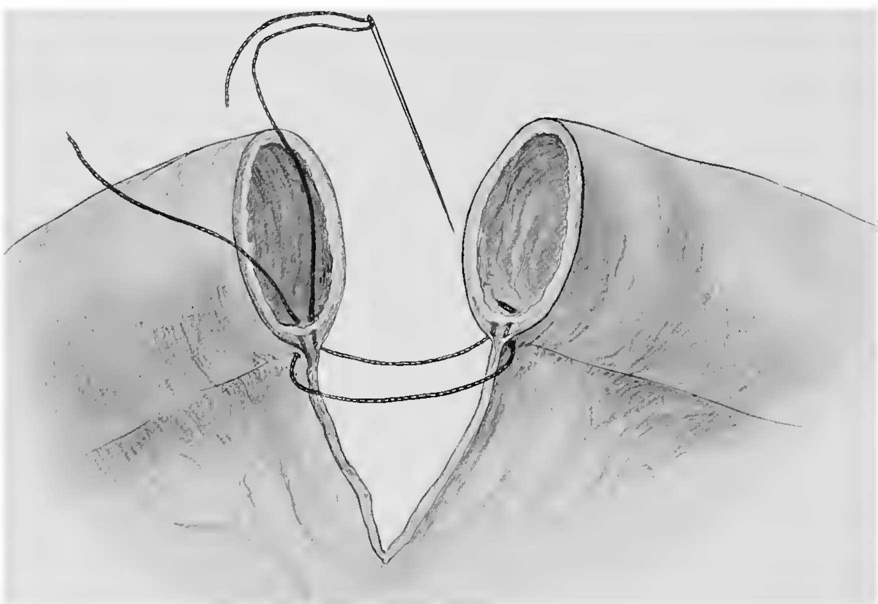
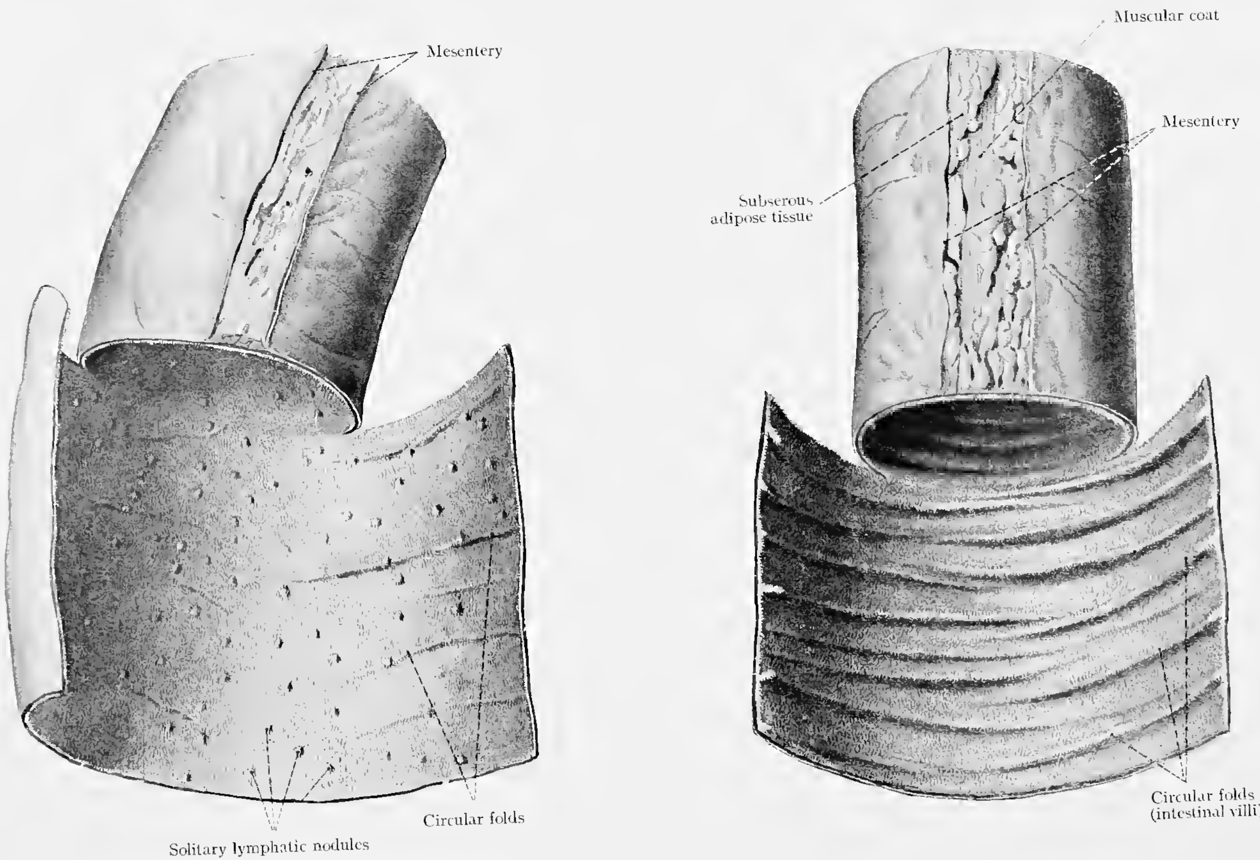


FIG. 64.—MAUNSELL'S MATTRESS MESENTERIC STITCH.

The Seromuscular Penetrating Mattress (Jobert[1]-Senn[2]).—In closing small perforating wounds of the intestine, it is difficult to control hemorrhage, and approximate the peritoneum with the same stitch. Jobert has described a stitch which serves this purpose with success. It is a combination of the perforating mattress with the seromuscular stitch. The stitch begins on one lip of the wound, like the Lembert, reaching down only into the muscularis mucosæ. It then crosses the hole and penetrates

[1] Jobert. Archiv. générales de Médicine, 1824.
Senn. Intestinal Surgery, 1889, p. 168.



FIGS. 65, 66.—TWO VIEWS OF THE SMALL INTESTINE.
To show the wide space covered by the mesenteric attachment. (From Sobotta.)

all coats of the opposite lip, entering the bowel lumen. From this point the stitch again escapes from the bowel, through all coats, ending as a Lembert, on the first lip of the wound (Fig. 67). Upon tying this stitch the edges of the wound are rolled in and the bleeding stopped by compression. Fig. 68 shows the stitch in cross section.

It is generally felt by surgeons that the presence of knots on the peritoneal surface of the intestine is a frequent cause of adhesions. This circumstance has been emphasized in the writings of Halsted and of Con-

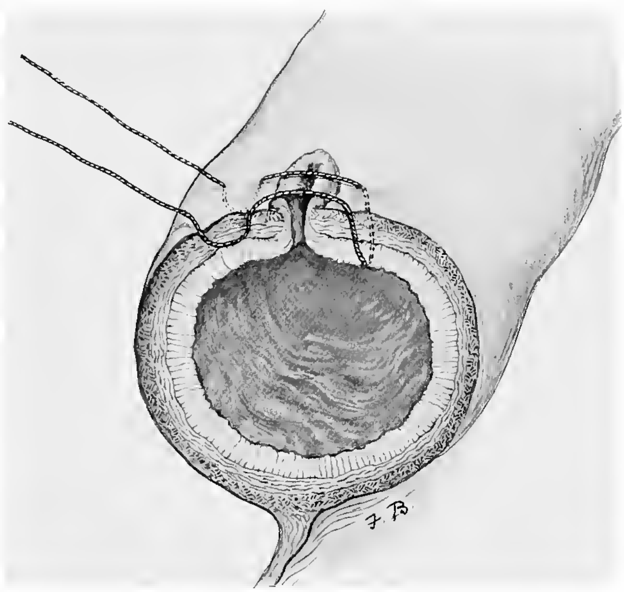


FIG. 67.—SEROMUSCULAR PENETRATING MATTRESS.
Cross section, showing stitch loosely introduced.

nell, and the suggestion made that the outside knots be done away with as far as possible. It is difficult, however, to show exactly how much irritation is caused by the knots, because the bruising of the peritoneum near the suture may lead, of itself, to the formation of adhesions. As far as personal experimental work goes, there seems to be more danger of adhesion formation from rough handling of the peritoneum than from outside knots.

The comparative value of the interrupted and the continuous stitches is another mooted question. For the interrupted stitch it may be said that it never can constrict the lumen, because each stitch pulls parallel to the

long axis of the bowel. An excessive edge may, however, be turned in by successive layers of stitches and thus narrow the intestine; but this accident can also occur after use of a continuous stitch. The giving way of a single stitch during the early hours of healing is not necessarily disastrous if two layers of sutures are employed, as the remainder of the circumference is unaffected by the giving way of one stitch, and the inner layer will probably protect the small gap left by the deficient stitch. If the seromuscular stitches are properly placed so as to include the muscularis mucosæ, and are made as narrow as compatible with good anchorage, the danger of slipping will be reduced to a minimum. Leakage of intestinal contents between interrupted stitches is not to be anticipated, for the first step of the process of repair is the rapid distention of the inturned edges with edema and with blood. The swollen edges at once plug all openings, and the greater the pressure within the intestine, the more effective is this valve action of the swollen edges. After twenty-four hours enough exudate has oozed into the tissues about the joint to glue together the peritoneal surfaces and thus remove further danger of leakage.

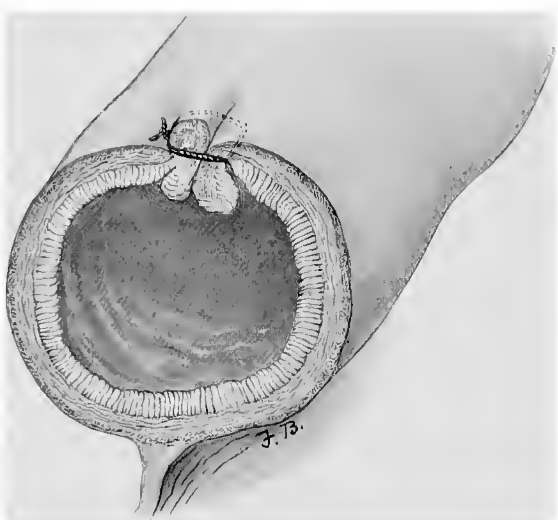


Fig. 68.—Seromuscular Penetrating Mattress.
Showing stitch pulled tight.

Horsley[1] feels certain that a continuous stitch is superior to a series of

[1] Horsley, J. S. Annals of Surgery, 1903, p. 741.

interrupted stitches, because, by acting as a splint, it supports the joint, while at the same time it completely seals in the line of union. It is true that rest is essential to repair, and it is reasonable to suppose that the immediate approximation obtained with a continuous stitch is more perfect and tight than that given by interrupted stitches. This view, however, loses its importance when a comparison is made between joints done, the one with a continuous, the other with two layers of stitches. The inner stitch is always a continuous one, and provides the splint action accredited to the continuous stitch, whatever type of outside stitch is employed. A fair distinction might be made between the interrupted mattress anastomosis of Connell and one of the methods which employs a single continuous seromuscular stitch. It will be recalled that the mattress anastomosis is accomplished entirely by means of interrupted mattress stitches which penetrate all the bowel coats. It is the aim of the method to place the stitches very near to the cut edges, so that the edges will be inverted as little as possible. Theoretically there would be danger of leakage between the stitches, but practically it has proved a very safe and strong method. Although I have no specimens to show it, there is every reason to believe that the cut edges swell up and block the interstices between the stitches in the same way that they were observed to act with the suture in two layers, and with one layer with the segmented ring. Horsley's experiments, to show that adhesion between serous surfaces does not necessarially follow their continuous and close apposition, did not take into account the effect of the cut edges in pouring out serum into all parts of the joint. It was shown in the ring series that the inflammatory reaction began at the cut edges at once. As a matter of fact, it is the accepted opinion that the surgeon should never subject his stitches to the dangers of distention and increased peristalsis. This is avoided by dividing the operation into two stages whenever distention is found. The usual routine is to resect and drain at the first sitting, followed by suture several days later, after the intestines have been given a sufficient rest. It is probably just as dangerous to submit a continuous suture to the test of distention and of violent peristalsis as it is the suture in two layers, the outer of which is interrupted.

For the continuous stitch it may be said that it is more rapid than the interrupted method, need never be drawn into a purse-string, if occasionally

interrupted with knots, and leaves a smooth surface at the outside joint angle. The ultimate scar formation is supposedly less dangerous after the interrupted suture; but this question is so involved with the width of the inturned edge that no general statement can be made. Both continuous and interrupted stitches are perfectly efficient if correctly placed, and can be substituted for each other to fit the circumstances.

CLAMPS.

Intestinal Clamps.—There are several methods of controlling leakage of contents during the suture of an opened viscus. For intestinal operations it was formerly found sufficient for the assistant to pinch the bowel with the fingers, but this method removed the assistant from further participation in the operation, while demanding of him the utmost care to avoid relaxation of the fingers, which the fatiguing nature of the position made it difficult to carry out.

The next step in the evolution of the technic of leakage-control was the constriction of the gut lumen by means of a silk tie, or a piece of gauze. This method, although freeing the hands of the assistant, is inferior to simple finger-compression since it requires the perforation of the mesentery at its junction with the bowel. The terminal branches of the third vascular arch, which is nearest the intestine, travel at a right angle to the long axis of the bowel (Fig. 79), and, theoretically, might not be injured by placing a ligature about the bowel if the mesenteric incision avoided these vessels. On the contrary, the close relation of these terminal branches to each other makes it really difficult to avoid them, especially if the mesentery be opaque with fat. Just how much damage is done by wounding the small vessels placed at the mesenteric border would be hard to determine, but, on general principles, it is safer to preserve the entire blood supply of an organ when possible.

The adaptation of clamps has proved of great value to gastro-intestinal surgery, and has superseded both of the crude measures just mentioned. It is one of the rare situations in which special instruments are serviceable in intestinal work.

The simplest method of compressing the intestines is by means of the straight circumcision clamp (Fig. 69). A clamp similar to this has been

devised by Murphy, the blades of which are bent at a right angle to the spring handle. This adds very little to the value of the instrument, while, on the contrary, the circumcision clamps are much more readily obtained. As expedients to prevent the tissues from slipping through the blades, the latter are furnished with fenestræ and with teeth. These may prove useful additions to the plain blade in the operation of circumcision, but they have no place in intestinal work, because the circumcision clamp is only used in end-to-end sutures of the intestines where the clamp is placed so far from the cut edges as to render the question of slipping of no importance. However, the clamps about to be described are used both for intestinal and for gastric operations, where a tight grasp of the fold is essential. The jaws of all clamps which are used merely to compress the intestine or the stomach should be covered with rubber tubing in order to interpose a cushion between the intestine and the hard surface of the instrument. Attention should be called to the proper size of tubing to be chosen for this work, because in lateral anastomosis, and in all stomach operations, the size of the rubber tubing is the key to the success of the clamp. Generally speaking, if the tubing is of a caliber which admits its being easily slipped over the blade of the clamp, no compression which it is safe to apply to the included intestine or stomach will prevent the tubing from rotating around the blade, under the influence of the drag of the tissues. It seems obvious that the addition of teeth or of windows to prevent the rubber from turning is a wrong principle. The tubing should be so small that it requires stretching to draw it over the blade. The lubrication of the rubber with lysol will make the procedure comparatively easy. In the author's clamps, described later, there are two narrow grooves which run lengthwise on the inside of the blades, but it is probable that their presence is of no additional value to the clamp. Fig. 70 shows the correct size of tubing for gastroenterostomy and for intestinal clamps.

FIG. 69.—STRAIGHT CIRCUMCISION CLAMP FOR INTESTINE.

Length of blade, $2\frac{1}{4}$ inches; width of blade $\frac{3}{8}$ inch; length of handle, 3 inches.

FIG. 70.—RUBBER TUBING FOR INTESTINAL AND SMALL STOMACH CLAMPS.

Diameter about $\frac{3}{16}$ inch.

For clamping the intestine any of the smaller stomach clamps are serviceable. Krause's clamp is very good on account of the full curve of the blade which allows the handle to be tucked away from the field of operation. This clamp is described below. In the days when intestinal clamps were not boiled as a routine in all abdominal layouts various contrivances came into vogue as makeshifts in emergencies. Although it would seem that the assistant's fingers are superior in every way to instruments which penetrate the mesentery, yet the methods of Pean and of Maylard are so ingenious that drawings have been made from Binnie's Surgery to illustrate their technic. Figs. 71 and 72 are self-explanatory.

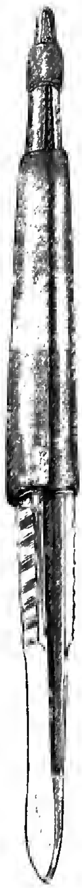


Fig. 71.—Maylard's Method of Using Forceps for Intestinal Clamps. (Drawn from Binnie.)

Gastric Clamps.—*For gastroenterostomy and all stomach operations except the larger resections, a small clamp is desirable.* Fig. 73 shows *Krause's clamp* which has been previously mentioned. The special characteristics of this clamp are its thin, flat blades, the curve of which is much fuller than that of the other small clamps. It is claimed that in difficult operations upon the pylorus and the first portion of the duodenum the bend in the blades is very useful as an aid in getting a good bite of the intestine when it is necessary to work in a deep hole.

Figs. 74 and 76 illustrate the *author's modification* of the Doyen clamp. It is a slight instrument with narrower, less fully curved blades than the Krause clamp, while the handles are longer. This clamp was designed for use in gastroenterostomy. The actual dimensions of this and all other clamps included in this description are given with the cuts.

There are occasional cases where a straight clamp is of use. Fig. 75 represents *Scudder's straight clamp.* The blades are toothed and fenestrated. This clamp and Moynihan's straight clamp resemble each other in that both have straight fenestrated blades of about the same length.

In extensive resections of the stomach long, heavy clamps are re-

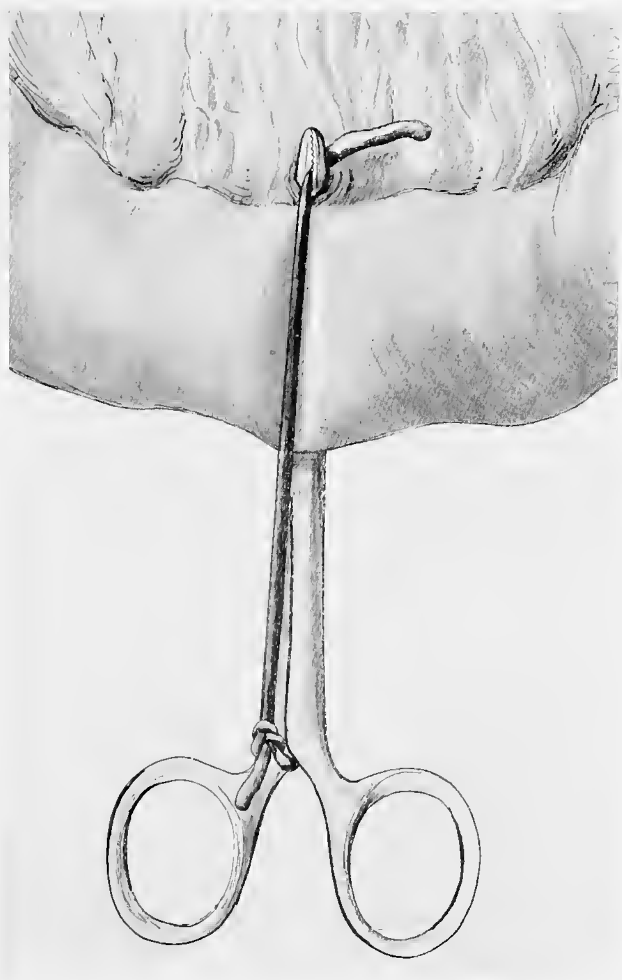


Fig. 72.—Pean's Method of Using Hemostatic Forceps and Rubber Tube in Place of Clamp. (Drawn from Binnie.)

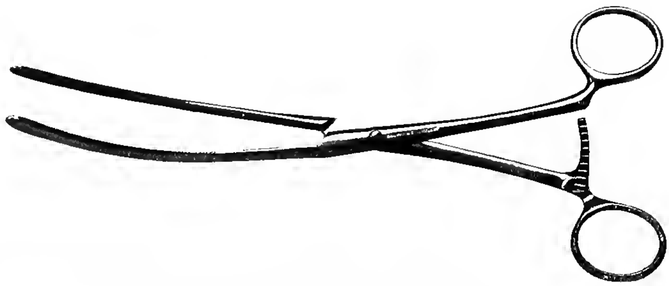


FIG. 73.—KRAUSE'S STOMACH CLAMP.

Length of blade, five inches; width of blade, $\frac{1}{4}$ inch; curve of blade, $\frac{1}{2}$ inch; length of handle, $4\frac{3}{4}$ inches.

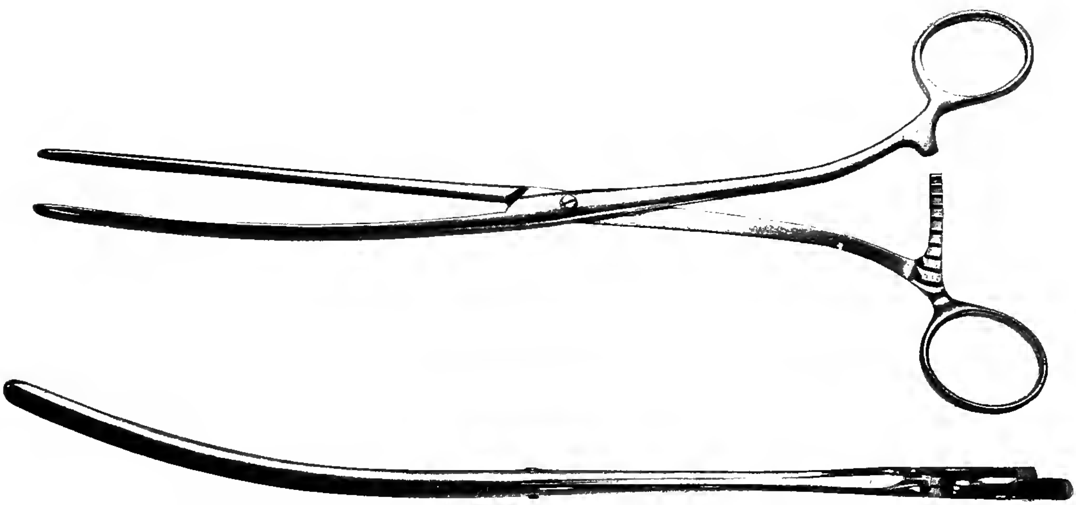


FIG. 74.—AUTHOR'S STOMACH CLAMP.

Two views. Length of blade, $5\frac{1}{8}$ inches; width of blade, $\frac{1}{4}$ inch; curve of blade, $\frac{1}{4}$ inch; length of handle, $4\frac{3}{4}$ inches.

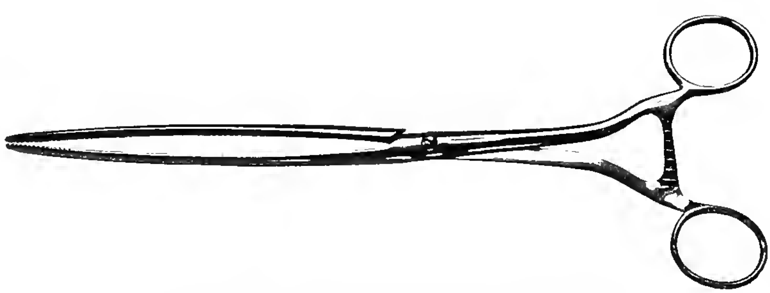


FIG. 75.—SCUDDER'S STRAIGHT STOMACH CLAMP.

Length of blade, $5\frac{1}{4}$ inches; width of blade, $\frac{1}{4}$ inch; length of handle, $4\frac{1}{8}$ inches.

quired. Harrington has devised two clamps, one with curved, the other with straight blades, which he uses in all stomach operations. The blades, made without teeth or corrugations, are longer and heavier than the usual

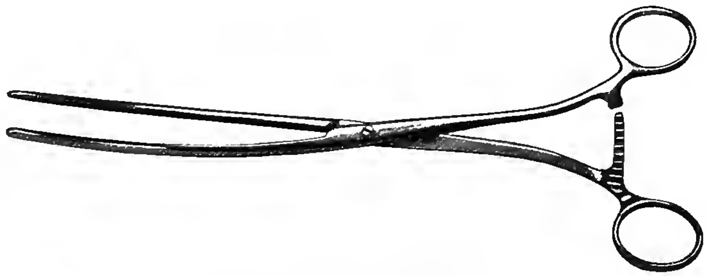


FIG. 76.—AUTHOR'S STOMACH CLAMP.
Compare in size with Figs. 77, 78.

gastroenterostomy clamps. This clamp is specially adapted for resections of the middle portion of the stomach. Fig. 77 is a cut of Harrington's

FIG. 77.

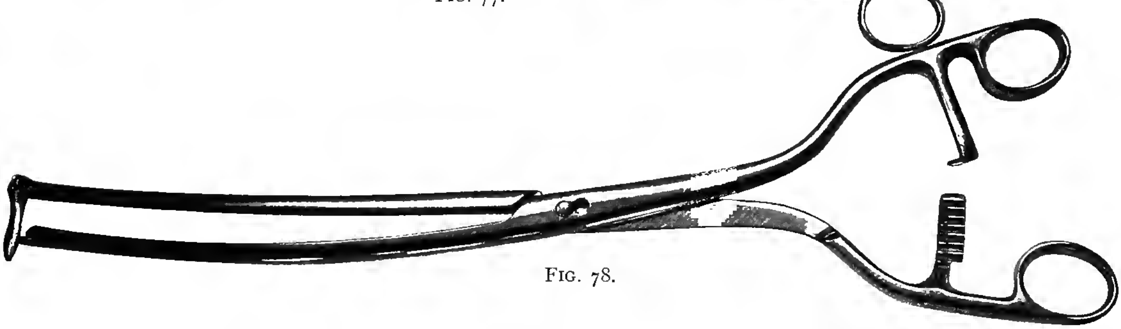


FIG. 78.

FIG. 77.—HARRINGTON'S STRAIGHT STOMACH CLAMP.
Length of blade, 8 inches; width of blade, $\frac{5}{16}$ inch; length of handle, $4\frac{1}{2}$ inches.
FIG. 78.—KOCHER'S CRUSHING CLAMP.
Length of blade, $7\frac{1}{4}$ inches; width of blade, $\frac{5}{8}$ inch; curve of blade, $\frac{3}{4}$ inch; length of handle, $6\frac{7}{8}$ inches.

straight clamp which is used in Figs. 180 and 181 in the technic of resecting the middle portion of the stomach.

One of the very valuable stomach clamps is Kocher's so-called *crushing clamp* (Fig. 78). The blades of this clamp are very heavy and strong,

while their curve is pronounced. The ends of the blades can be fastened by a small lever, thus preventing the end of the blades from spreading, as they are tightened on the fold of stomach. Kocher, in his well-known technic, uses his instrument to crush the stomach before resecting, but the clamp is also very reliable for pylorectomy when crushing is not desired. When employed for crushing, the blades are bare, but for merely obtaining a secure grasp of the tissues a tight-fitting rubber cover is applied. (The clamps used for these illustrations were made by Codman & Shurtleff, of Boston.)

CHAPTER III.

THE ANATOMY OF THE INTESTINES.

The general relationship of anatomy to the various pathological processes which are found within the abdomen is not considered here. There are, however, three anatomical subjects which bear directly upon the technical descriptions to be given later. These subjects are the following:

(1) The blood supply of the intestine.
(2) The lymphatics of the intestine.
(3) Intestinal localization.

THE BLOOD SUPPLY OF THE INTESTINES.

The blood supply of the intestines is derived from the superior mesenteric and from the inferior mesenteric arteries. The superior mesenteric artery supplies the whole length of the small intestine, except the first part of the duodenum, which is supplied by the pyloric and the pancreatico-duodenal branches of the hepatic. The superior mesenteric also supplies the cecum, the ascending, and the transverse colon. The descending colon and the sigmoid flexure, as well as the greater part of the rectum, are supplied by the inferior mesenteric artery.

The Blood Supply of the Small Intestine.—The intestinal arteries which arise from the main trunk of the superior mesenteric "consist of two groups: the larger number from ten to twelve branches, and arise from the large primary arch of the superior mesenteric artery; the smaller, from eight to twelve in number, arise from the terminal portion of the superior mesenteric. These branches pass between the two layers of the mesentery, the large branches traversing a distance of 7–8 cm., the small 3–5 cm., after which they bifurcate. The branches arising from the bifurcation anastomose with the neighboring intestinal arteries, and form, in this manner, a first series of arches, the convexity of which is turned toward the intestine. From these arches, new branches arise, to the number of forty or fifty, which run parallel to each other until they bifurcate. The branches,

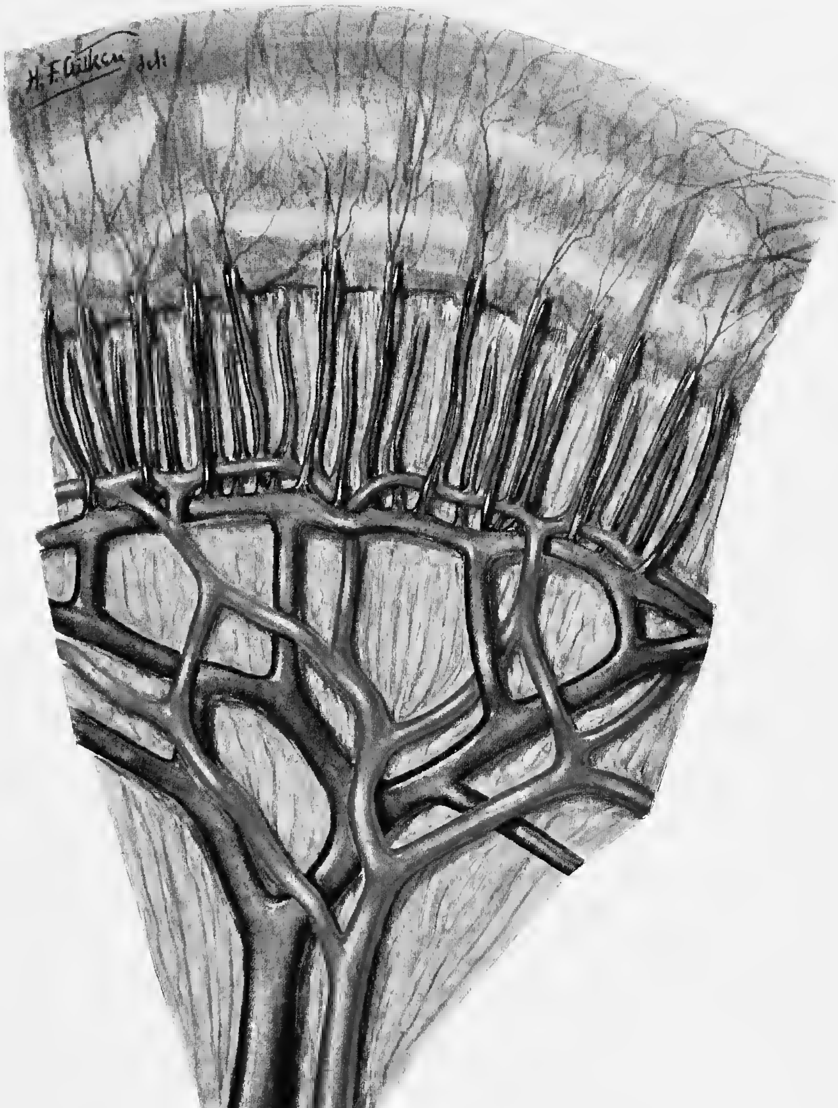


FIG. 79.—THE BLOOD-VESSELS OF THE MESENTERY OF THE SMALL INTESTINE.

Drawn from an actual dissection. One layer of the mesentery has been removed, exposing the vessels. The layer of mesentery remaining forms the background for the vessels. Note the anastomosis of the branches of the superior mesenteric artery, to form arches. In this specimen there are three series of arches. The vasa recta arise at a distance from the intestinal border, alternating as to the side of the intestine which they supply.

arising from the bifurcation, anastomose in their turn, thus resulting in a second series of arches placed nearer to the mesenteric border of the intestine. The small vessels which take their origin from the second series of arches anastomose again to form a third series of arches, from which arise the terminal branches, which are distributed to the walls of the intestine" (Fig. 79). (Poirier and Charpy.[1])

As a continuation of the above statements by Poirier and Charpy the following is quoted from the report of Monks,[2] who has examined a large number of specimens for the purpose of making clear the vascular anatomy of the mesentery of the small intestine. Previous work has been done on this subject by Professor Dwight,[3] of Harvard:

"Opposite the upper part of the bowel the mesenteric vessels are distinctly larger than opposite any other part of it. These vessels grow smaller and smaller as we pass downwards until the lower third of the gut is reached, where they remain about the same size as far as the ileocecal valve. The arrangement of the mesenteric vessels has some features which intimately concern the subject in hand (intestinal localization), and which I shall describe with some detail. Diagrammatically speaking, the main branches of the superior mesenteric artery unite with each other by means of loops which are called, for convenience, 'primary loops;' in some parts of the tube, 'secondary loops;' and even occasionally 'tertiary loops' are superimposed upon these. From these loops little straight vessels—the vasa recta already referred to—run to the bowel, upon which they ramify, alternating, as a rule, as to the side of the intestine which they supply. The mesenteric veins are arranged in a manner somewhat similar to the arteries. Opposite the upper part of the bowel there are only primary loops. Occasionally a secondary loop appears, but it is small and insignificant as compared with the primary loops, which are large and quite regular. As we proceed down the bowel secondary loops become more numerous, larger, and approach nearer to the bowel than the primary loops in the upper part. As a rule, secondary loops become a prominent feature at about the fourth foot. As we continue farther downward the secondary loops (and, possibly, tertiary loops) become still more numerous and the primary loops

[1] Poirier et Charpy. Traité d'Anatomie Humaine, T. II, p. 771.

[2] Monks, G. H. Trans. Am. Surg. Asso., 1903.

[3] Dwight, T. Proc. Asso. Amer. Anatomists, 1897, Washington, 1898, x, 79-81.

smaller, the loops all the time getting nearer and nearer to the gut. Opposite the lower part of the gut the loops generally lose their characteristic appearance, and are represented by a complicated network. Opposite the upper part of the intestine the vasa recta are from three to five centimeters long, when the loop of small intestine to which they run is lifted up so as to put them gently on the stretch. They are straight, large, and regular, and rarely give off branches in the mesentery. In the lower third they are very short, being generally less than one centimeter in length. Here they are less straight, smaller, less regular, and have frequent branches in the mesentery."

The Blood Supply of the Large Intestine.—The blood supply of the large intestine has no special surgical features which require a detailed description. The cecum, the ascending and the transverse colon are supplied by branches of the superior mesenteric artery,—*i. e.*, the ileocolic, the colica dextra, and the colica media. The descending colon and the sigmoid flexure are supplied by branches of the inferior mesenteric artery, —*i. e.*, by the colica sinistra and the sigmoid arteries,—while the rectum is supplied by the three hemorrhoidal arteries which arise from the inferior mesenteric, the internal iliac, and the internal pudic arteries.

The arrangement of the blood-vessels of the large intestine has its nearest approach to that of the small intestine in those portions most commonly affected with surgical disease. New growths of the large intestine (excepting the rectum) are usually situated either in the sigmoid, the transverse colon, or the cecum, where the movability of the gut allows a relatively easy approach to the vessels.

The colica media artery derives additional importance from its relationship with the gastrocolic omentum, where it may be wounded in operations upon the stomach. The colica media artery inosculates on either side with the colica dextra and the colica sinistra. The large primary arches formed in this manner are plainly exposed when the great omentum is reflected upwards. When the lesser peritoneal cavity is opened during the operation of posterior gastroenterostomy, a bloodless spot is chosen under the sweep of the primary arch as it runs to the left to join the colica sinistra artery.

THE LYMPHATICS OF THE INTESTINES.

The following anatomical description is quoted practically verbatim from Poirier, Delamere, and Cunéo:[1]

"**The Lymphatics of the Large Intestine.**—*Lymphatics of the Iliopelvic Colon.*—The lymphatics of the iliopelvic colon (sigmoid flexure) at first traverse some small glands which are attached to the terminal branches given off by the paraintestinal arch and formed by the anastomosis of the three sigmoid arteries. They then terminate in glands placed over the inferior mesenteric artery.

"*Lymphatics of the Descending Colon.*—The lymphatic vessels of the descending colon present a somewhat similar arrangement to that of the iliopelvic colon. We need only note the poorly developed glandular apparatus attached to this part of the large intestine.

"*Lymphatics of the Transverse Colon.*—The lymphatic apparatus of the transverse colon is much more developed. The juxtaintestinal glands (between the arch of the colica media artery and the intestinal border) are here numerous, especially in the neighborhood of the two extremities of the transverse colon. Further, one almost constantly finds one or two glands situated in the angle of the bifurcation of the middle colic as well as two or three others placed along the trunk of this artery. The trunks coming from the latter pass into the glands of the superior mesenteric chain.

"The lymphatics of the transverse colon communicate to a large extent with those of the great omentum, so that they are brought into relation with the lymphatics of the inferior border of the stomach.

"*Lymphatics of the Ascending Colon.*—The collecting trunks emanating from the ascending colon at first traverse some few juxtaintestinal glands; they then meet a gland which is, however, inconstant, placed on the course of the ascending colic artery, and finally terminate in the glands of the superior mesenteric chain.

"**Lymphatics of the Cecum and Appendix.**—The lymphatics of the cecum and appendix are much more developed than those of other segments of the large intestine. This is especially true in the case of the appendix, the lymphoid tissue of which is well known to be abundant.

"*The ceco-appendicular collecting trunks* follow pretty closely the course of the blood-vessels. This fact will enable us to divide them into three groups: the anterior cecal, the posterior cecal, and the appendicular trunks, which respectively accompany the vessels of this name.

[1] Poirier, Delamere, and Cunéo. The Lymphatics, 1903.

"(a) *The anterior cecal collecting trunks* appear on the anterior surface of the cecum. They run upwards and inwards, traversing one or two small glands situated in the thickness of the anterior ileocecal fold, and then terminate in a glandular mass placed on the terminal segment of the ileocolic artery.

"(b) *The posterior cecal collecting trunks* follow the course of the artery of this name. Like the preceding, they traverse some small glands —the posterior cecal. The latter, from three to six in number, are situated on the posterior aspect of the cecum, at the junction of this surface with the internal surface. Except in those rare cases where the coalescence of the posterior surface of the cecum and the parietal peritoneum is complete, these glands are covered by the visceral layer of peritoneum, which binds them to the posterior surface of the cecum. The posterior cecal lymphatics terminate in the ileocecal glandular group.

"(c) *The collecting trunks of the appendix*, four or five in number, run up between the layers of the mesoappendix, accompanying the appendicular artery. Like this artery they cross the posterior surface of the terminal segment of the ileum, then penetrate into the mesentery, and terminate in the ileocecal glandular group. In their course these lymphatics traverse some small glands which we class under the generic term of appendicular glands. In the large majority of cases these glands, from one to three in number, are placed in the retroileal segment of the mesoappendix: they may then be styled the retroileal appendicular glands. Finally some of the glands of the mesoappendix may be placed immediately against the cecum, above the origin of the appendix; these are the juxtacecal appendicular glands.

"**The Lymphatics of the Small Intestine.**—The lymphatics of both the large and the small intestine form two systems relatively independent of each other, one of which is attached to the mucous layer, the other to the muscular coat. The mode of termination of the collecting trunks of the small intestine is not the same in the region of the jejunoileum as in that of the duodenum.

"*Lymphatics of the Jejunoileum.*—The collecting trunks, which are extremely numerous, make their appearance in the neighborhood of the mesenteric border of the intestine. If examined in the living subject, during intestinal digestion, they appear as slightly bossed channels of varying caliber, especially noticeable on account of their milky appearance. Though these glands appear, at first sight, to be indiscriminately scattered between the two folds of the mesentery, if observed more attentively we may convince ourselves that they are arranged on some fairly definite plan. It is also

possible to divide them into three groups which vary in importance and signification.

"**The mesenteric glands** of the small intestine constitute one of the most important glandular centers in the human system. They vary in number from 130 to 150 (Quain), and their size varies greatly in different subjects.

"These glands may be divided into three or more distinct groups:

"(1) *The primary group* is made up of some small glands placed in the course of the terminal arterioles which spring from the last anastomotic arch of the superior mesenteric artery (vasa recta). This group may be considered as simple interrupting glandular nodules which have no morphological fixity.

"(2) *A second group* comprises the glands placed in the course of the primary branches of the superior mesenteric artery, at the level of the first anastomotic arch formed by these vessels. These glands, which are larger than the preceding, are the true regional glands of the small intestine.

"(3) *The third group* is found around the trunk of the superior mesenteric artery, and more particularly about the commencement of this vessel. This group does not properly belong to the jejunoileum, as it receives, in addition, the efferents of the regional glands of the cecum ascending and transverse colon, duodenum, and even the efferents of certain glands connected with the stomach.

"The second group of glands are especially numerous in the portion of the mesentery which corresponds to the jejunum. There is a progressive diminution in their number in each given segment of the mesentery until the terminal segment of the ileum is reached. Here in this terminal segment and in the ileocolic region of the mesentery the glands reappear in numbers and form an important mass around the ileocolic artery. The collecting trunks for these glands form two systems relatively independent of each other, one of which is attached to the mucous coat, and the other to the muscular coat of the intestine.

"**Lymphatics of the Duodenum.**—The lymphatics of the duodenum end in numerous collecting trunks which are arranged on the same plan as those of the jejunoileum, but the pancreas divides these vessels, like the corresponding blood-vessels, into two groups—an anterior group, the vessels of which end in glands placed on the prepancreatic vascular arch; a posterior group, the lymphatics of which terminate in the satellite glands of the retropancreatic arch. From these glands, the pre- and the retropancreatic, run two systems of efferents. Some, ascending, terminate in the glands of the hepatic chain. Others, descending, are grouped around the superior

mesenteric artery, at the spot where this vessel crosses the third part of the duodenum.

"The close relations which exist between the lymphatics of the duodenum, on the one hand, and those of the common bile duct, on the other, should be noticed. We shall see, later on, that anastomoses are also present between the lymphatics of the duodenum and those of the pyloric portion of the stomach."

INTESTINAL LOCALIZATION.

Intestinal localization, as a surgical procedure, has been rendered a practical possibility by the researches of Monks.[1] Henke,[2] Sernoff,[3] Weinberg,[4] and Mall[5] have also done valuable work upon the position of the intestines within the abdomen, but their results have so little bearing upon surgical anatomy that they are omitted here.

The following description is a partial summary of the investigation of Dr. Monks; it is illustrated with ten drawings kindly loaned by him:

In attempting to distinguish one portion of the small intestine from another two main difficulties are encountered. (1) Although the upper portion of the small intestine is called the jejunum, and the lower the ileum, yet there is no fixed point of transition from one to the other. For this reason we may be uncertain as to the correct name to apply to a large number of coils of intestine whose position we may know by exact measurement. It is better to locate a coil of intestine by its distance from the duodenojejunal flexure than by classing it as jejunum or ileum. (2) Though the nomenclature is confusing, a further difficulty is added by the variation in the length of the small intestine, which was found by Monks to range between fifteen and thirty feet.

The first problem to be met after drawing out an intestinal coil through an abdominal incision is to classify the coil according to its general position, that is, whether the coil belongs to the upper, middle, or lower portion of the digestive tube. The root of the mesentry of the small intestine is connected to the posterior abdominal wall obliquely, the upper end being attached just to the left of the second lumbar vertebra, the lower end to the right iliac fossa, at an indefinite point about six inches distant from the first.

[1] Monks, G. H. Trans. Am. Surgical Asso., 1903.

[2] Henke. His's Archiv, 1891.

[3] Sernoff. Internat. Monatschr. für Anat. u. Physiologie, 1894.

[4] Weinberg. *Ibid*, 1896.

[5] Mall, F. Johns Hopkins Hospital Bulletin, Vol. IX, 1898, p. 197.

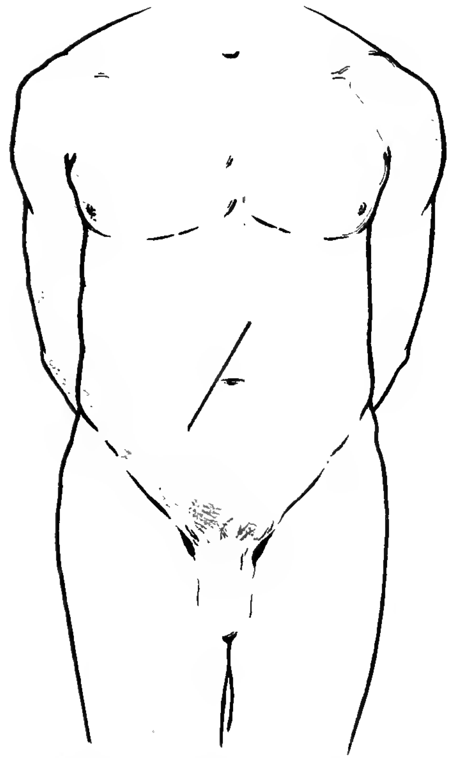


FIG. 80.—Showing approximately the line of the mesenteric root as traced on the abdominal wall. (Monks.)

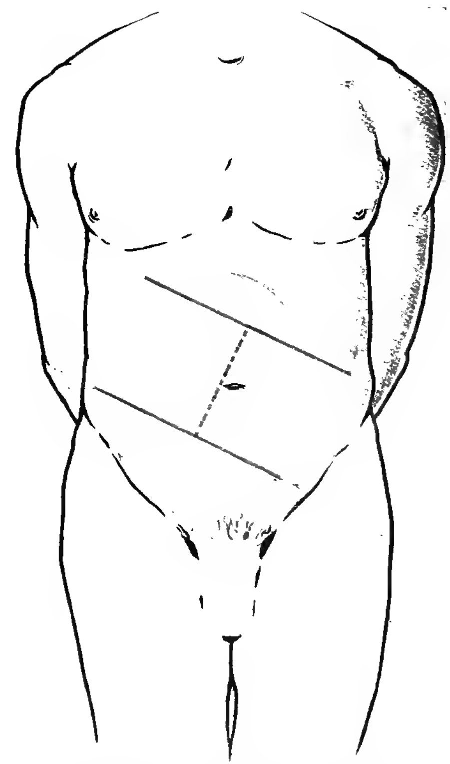


FIG. 81.—Showing the two oblique lines (black) drawn at right angles to the two extremities of the line (dotted) of the mesenteric root. The upper, middle, and lower compartments here indicated contain in most cases the upper, middle and lower thirds of the small intestine respectively. (Monks.)

The outer surface of the abdomen may be marked off in the shape of a figure H, the crossbar being represented by a projection of the line of attachment of the mesenteric root, the upright lines being placed at either end. These lines will be situated obliquely in relation to the perpendicular of the body (Figs. 80, 81). Roughly, the upper six feet of the small intestine are usually confined to the left hypochondriac region, above the upper of the side lines of the H. The middle portion of the intestine is usually found in the middle of the abdomen, while the lower part is below the lower side line of the H, in the pelvis or in the right iliac fossa.

In identifying the position of a certain coil of intestine several factors should be considered.

(1) It would be of assistance to know the **length of the intestine,** though the great variations in the measurement of the tube render it impossible to prophesy what it will be in an individual case. Monks has found a certain number of times that a short intestinal tube was associated with a short mesentery. As the terminal arterioles (vasa recta) were found to be short also, in these cases of short mesentery, he suggests that the length of the vasa recta may give a clue to the whole length of the intestine. It is to be presumed that the mean length of the vasa recta is meant, since Monks himself found that these vessels varied much in length according to their position in the upper or the lower portions of the tube.

(2) **The size of the intestine,** though relative, has well-known characteristics. The diameter is greatest at the upper end, diminishing gradually until the lower third is reached, after which it remains the same down to the ileocecal valve. It varies much in life at any given point under the influence of distention and certain other conditions.

(3) **The thickness of the intestine** corresponds roughly to the size. The thick upper portion acquires this quality from the extra width of muscular walls, and from the presence of a large number of *valvulæ conniventes*. Toward the lower end the intestine becomes thinner, the valvulæ conniventes lose their characteristic appearance of pinkish-white rings until they wholly disappear at fourteen or fifteen feet below the end of the duodenum.

(4) **As to the color of the intestine,** the upper part is bright pink or red, with a large number of branching vessels. This color fades gradually, as we go downwards, to a pinkish or a yellowish-gray. To Dr. Monks's

statement may be added the great contrast between the cecum and the lower end of the ileum, for though this portion of the small intestine may be lighter in color than the jejunum, yet it is much darker than the cecum, the light gray tone of which offers a marked contrast to the darker shade of the ileum.

(5) **An examination of the blood-vessels of the intestine** furnishes some of the best evidence for the determination of the identity of a loop. As the observations of Dr. Monks have already been quoted above on this subject, it will only be necessary to state that, in the upper portion of the intestine, the mesenteric vessels have a simple arrangement, that is, in a single arch which is placed at a distance from the intestinal border (long vasa recta). As the lower end of the intestine is approached, the arrangement becomes more elaborate, a second, or even a third, arch being superimposed upon the other, the distance between the last arch and the intestinal border growing less. Near the lower end of the tube the vascular arrangement is less clearly marked, and consists of a confusion of anastomosing branches, from which spring a series of short vasa recta (Figs. 82, 83, 84, 85, 86, 87).

(6) **The thickness and the transparency of the mensentery** vary very much in different subjects, the more obese the patient the more opaque the mesentery. The thinnest part of the mesentery is adjacent to the thickest portion of the intestine,—*i. e.*, the upper end. The mesentery becomes thicker as we go downward, while the intestine becomes thinner. The translucency also varies with individuals. Dr. Monks has found transparent spots between the upper vasa recta in nearly all cases, regardless of fat deposit. These spots, which he calls "lunettes," disappear at about the eighth foot.

(7) **Small masses of fat** may be found in the lower third of the small intestine which project from the mesentery toward the bowel. These tabs of fat were seen many times by Monks, even in very thin subjects.

(8) **The determination of the direction** of any given loop of intestine is of high importance, even after the general situation of the coil has been located. The operations of gastroenterostomy and appendicectomy are good examples of the circumstances when a knowledge of the direction of the loop is an absolute necessity.

Monks, in working upon the cadaver, determines the direction of a

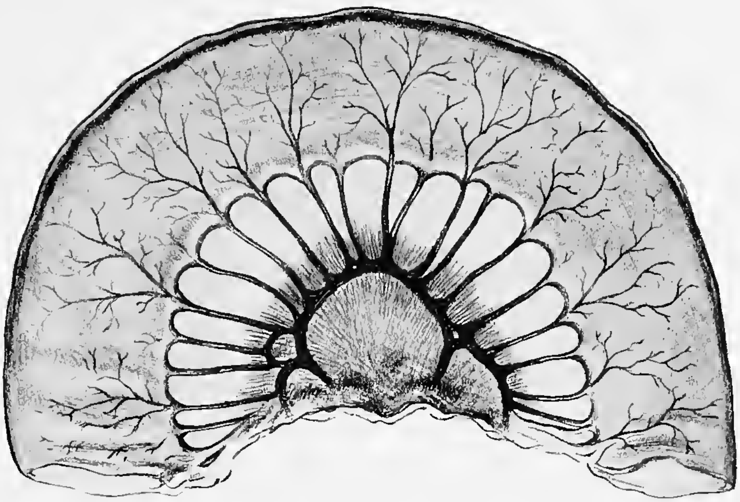


FIG. 82.—A loop of intestine, the middle of which is exactly three feet from the end of the duodenum. The gut is of large size. The mesenteric loops are primary and the vasa recta large, long, and regular in distribution. The translucent spaces (lunettes) between the vessels are extensive. Below, the mesentery is streaked with fat. The veins, which had a distribution similar to the arteries, are for simplicity omitted from this and from the subsequent drawings. The subject from which the specimen was taken was a male of 40 years, with rather less than the usual amount of fat. The entire length of the intestine was twenty-three feet. (Monks.)

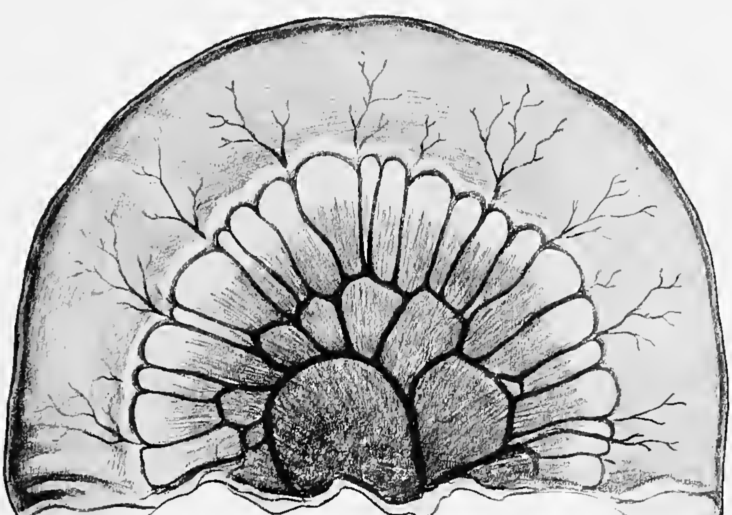


FIG. 83.—A loop of intestine at six feet. As compared with Fig. 82 the gut is somewhat smaller. The vascularity of the intestine and mesentery is less. Secondary loops are a prominent feature. The vasa recta are smaller. The lunettes are also present, but are not so large as in Fig. 82. The subject was a male of about 35 years, with an average amount of fat. The entire length of the intestine was twenty feet. (Monks.)

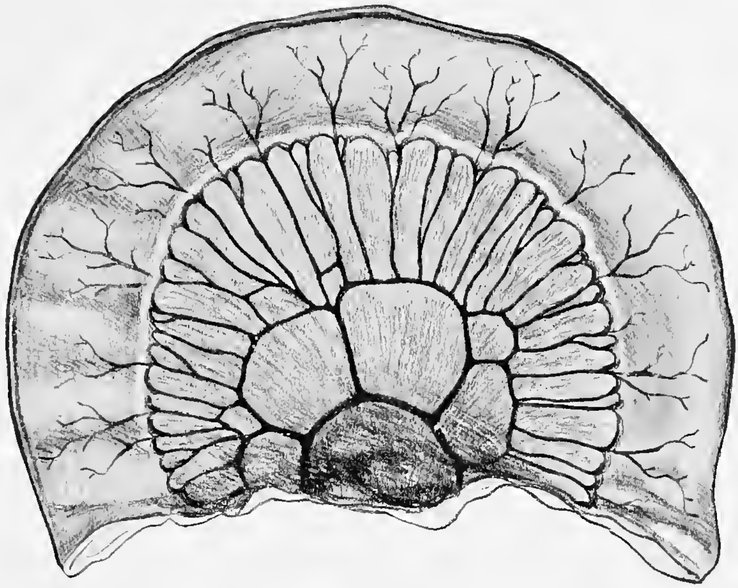


Fig. 84.—A loop of intestine at nine feet. The secondary loops are large; the vasa recta are somewhat irregular and show branches. No lunettes are present and the mesentery is streaked with fat, and is therefore somewhat opaque. The specimen was taken from the same subject which furnished Fig. 82. (Monks.)

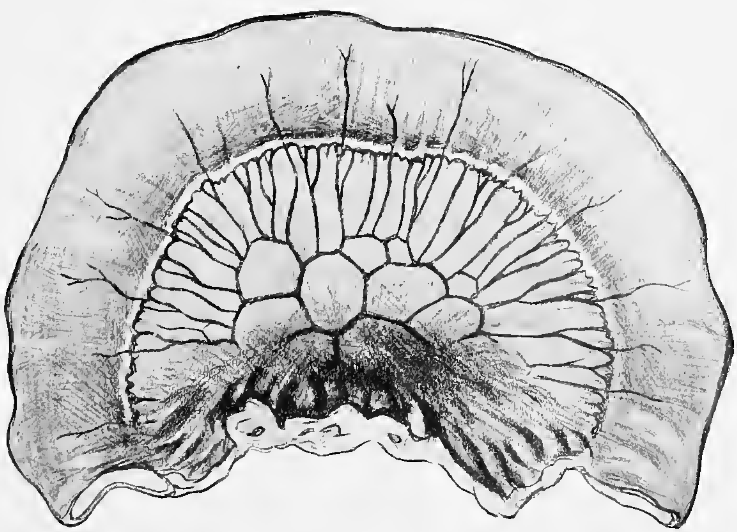


Fig. 85.—A loop of intestine at twelve feet. The vessels are smaller. The primary loops are lost in the fat, but secondary and even tertiary loops are visible. The vasa recta are shorter, more irregular and branching. The specimen came from the subject which furnishes Figs. 82 and 84. (Monks)

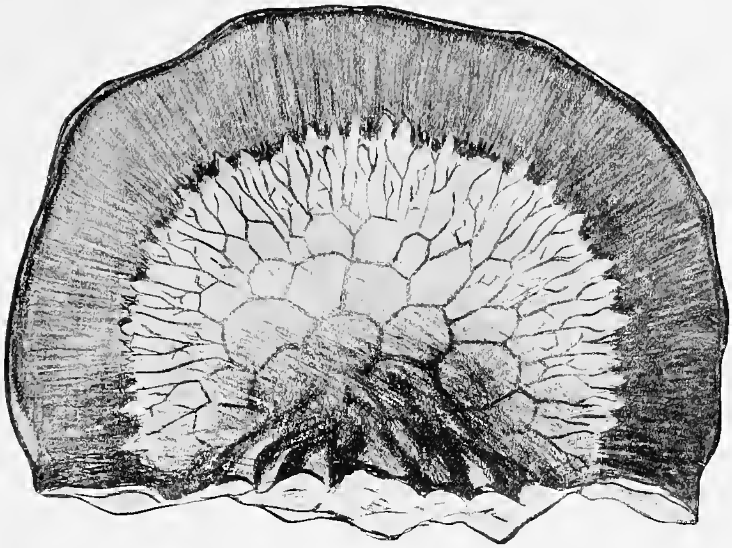


FIG. 86.—A loop of intestine at seventeen feet. The mesentery is opaque, and small tabs of fat begin to appear along the mesenteric border of the gut. The vessels are represented by a somewhat complicated network and are seen with difficulty in the thick fat of the mesentery. The specimen came from the subject which furnishes Figs. 82, 84, 85. (Monks.)

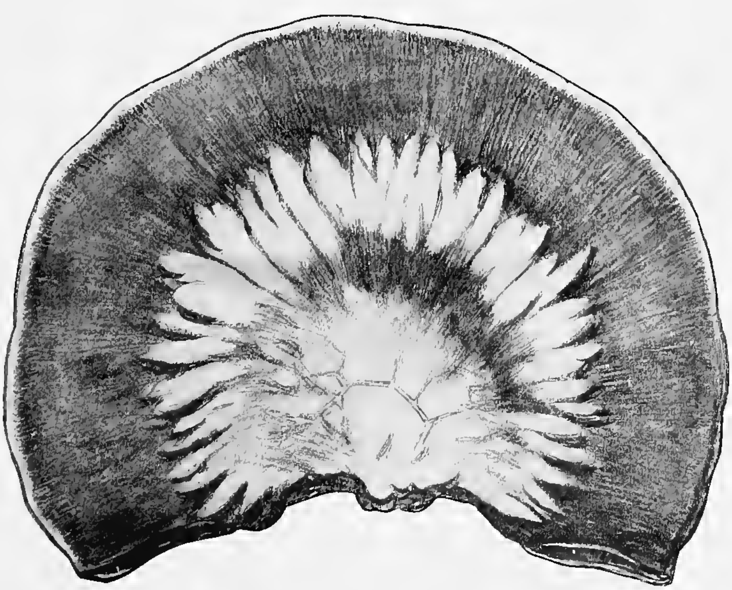


FIG. 87.—A loop of intestine at twenty feet. The gut appears to be thick and large. The mesentery is quite fat, opaque, and large, and numerous fat tabs are present. The vessels which are complicated are seen with difficulty, and are represented by mere grooves in the fat. The subject was a stout woman, and the entire length of the gut was twenty-one feet. (Monks.)

doubtful loop in the following manner: The mesentery is drawn tight and the fingers passed down to the attachment of the mesentery to the posterior abdominal wall. Palpation between the thumb and forefinger will make clear the line of mesenteric insertion, and disclose any twists in the mesentery itself. After freeing any possible twists the loop is arranged so as to be parallel to the line of attachment of its mesentery. This will leave the upper end in a proximal, and the lower end in a distal position, as it normally should be (Fig. 88).

The value of peristalsis in indicating the direction of the loop is usually underestimated. Dr. Monks feels that it is not reliable, and suggests that it may be impossible, in a given case, to tell whether the peristalsis does not run backward.

In 1884 Nothnagel[1] produced intestinal contractions by the application

FIG. 88.—Showing the method of determining the real direction of the gut by passing the thumb down on one side of the mesentery, and the fore and middle fingers down on the other, in the direction of the mesenteric loop. (Monks.)

of crystals of sodium and potassium to the surface of the gut. Bayliss and Starling have shown upon normal animals that the peristaltic contractions of the intestine, when evoked by local stimulation, are true coordinated reflexes, which are carried out by the local nervous mechanism (Auerbach's

[1] Nothnagel. Physiologie u. Pathologie des darms., Berlin, 1884.

plexus). They are independent of the connection of the gut with the central nervous system, and travel only in one direction, from above downwards. In 1887 Mall and Halsted[1] resected an intestinal coil, leaving it attached by its mesentery. They then sutured the upper end of the loop to the lower end of the alimentary canal, and the lower end of the loop to the intestine coming from the stomach. Subsequent observations upon the intestines of these animals both during life and after death showed that the peristaltic wave of the reversed coil travelled in a direction opposite to that of the unreversed intestine. Bayliss and Starling believe that the preponderance of the descending contractions in the normal animal may be due to the higher excitability of the fibers at the duodenal end of the gut, and to the constant presence of ascending augmentor stimuli. The law of intestinal peristalsis, as described by Bayliss and Starling, is comprised of two reactions: contraction above, and relaxation below the stimulated point. In order to demonstrate the intestinal movements upon animals it was necessary to isolate the intestines from the influence of the central nervous system (section of both vagi, both splanchnics, or of abdominal ganglia). The following remarks are quoted from a report of an experiment done by Bayliss and Starling[2] upon an animal in which the intestines were still connected with the central nervous system:

"On opening the abdomen in a warm saline bath, the intestines are seen to be collapsed and absolutely motionless. Local irritation, electrical or mechanical, either provokes no response at all, or if strong enough, causes a local contraction limited to the stimulated spot. On inserting a rubber capsule distended with air under pressure and connected with a piston recorder, the lever of the recorder remains permanently motionless. If contractions are present they are slight in extent and irregular in rhythm."

The statement of Bayliss and Starling applies to the accurate observation of the intestinal reflexes. For surgical purposes it is not necessary to produce contraction above and relaxation below the stimulated point, a rough test is merely needed to indicate the direction of the peristalis. Such a test is the following: An intestinal loop is drawn out, and its free border given a sharp pinch with the fingers. The hand is quickly drawn away in order to observe the beginning of the contraction which will be

[1] Mall, F. Reversal of the Intestines, Johns Hopkins Hospital Report, Vol. 1, p. 93.

[2] Bayliss and Starling. Journal of Physiology, 1899, Vol. XXIV, p. 120.

evoked. In response to the pinch there is no coordinated peristaltic movement, but the muscle fibers which were grasped by the fingers slowly begin to contract. The edges of the contracting area should be watched to see in which direction the contraction first spreads, for the distal side reacts first. In animals there is frequently a narrowing of the intestinal lumen both upward and downward over an area of several inches, so that only the earliest moment of the contraction is of importance. It is practically always possible, in normal intestines, to orient the coil by this manœuvre, but the very beginning of the contraction must be watched in order to make the test a success. In attempting to elicit a peristaltic reaction, a light brushing with the finger-tips is not sufficient, since it usually requires a firm pinch to obtain a contraction. Nothnagel's salt test has been recommended by Senn[1] and others, but at present it is not regarded as a practical surgical procedure.

[1] Senn, N. Practical Surgery, 1901, p. 844.

CHAPTER IV.

OPERATIONS UPON THE INTESTINES.

(I) End-to-end Anastomosis.
- (1) Plain.
- (2) Mattress.
- (3) Mechanical devices.
  - (*a*) Murphy button.
  - (*b*) Harrington ring.
  - (*c*) Robson bone-bobbin.

(II) Formation of Blind End.
- (1) Suture in two layers.
- (2) Purse-string.

(III) Lateral Anastomosis.
- (1) Plain.
- (2) Mattress.
- (3) Mechanical devices.
  - (*a*) Jaboulay's button: ring; bobbin.
  - (*b*) McGraw rubber ligature.

(IV) End-to-side Anastomosis.

(V) Colostomy.
- (1) Permanent.
  - (*a*) Left inguinal.
  - (*b*) Anterior.
- (2) Temporary.
  - (*a*) Rubber ligature.
  - (*b*) Glass tube.

ENTERECTOMY.

The excision of a part of the intestine is frequently demanded. The small intestine may be invaded at any point in its whole length by disease which can only be cured by its removal. Although primary lesions of a

serious nature are not often found in the jejunum, several cases have been reported where infarction of the mesenteric vessels or penetrating wounds have necessitated an operation upon this part of the gut, at its very beginning where it is most inaccessible. No portion of the large intestine, from the ileocecal valve to the rectum, is exempt from the possibility of operative attack.

A list of certain of the indications for enterectomy is appended below which conforms in the main with the views recently published by Moynihan:[1]

New Growths.—The most common form of new growths which occurs in the intestine is cancer, which, though occasionally met with in the small intestine, is most frequently found in the colon and rectum. Tillmann suggests that new growths tend to appear at points where the friction from the passage of the intestinal contents is greatest, as in the cecum and at the flexures of the colon. The same may be said of the sigmoid flexure and of the rectum. In the small intestine small round-cell sarcoma is occasionally encountered.

In resecting the intestine for malignant disease the mesenteric glands should be palpated and removed with a good margin of mesenteric fat. When no glands can be made out, a wide margin of mesentery is still necessary since the mesenteric fat may be infected before the glands themselves are large enough to be palpable. In excising the mesentery the margin referred to should be taken down toward the root of the mesentery to get between the infection and the deep glands.

Stricture may come as a result of inflammation or ulceration of the inner surface of the intestine. This is occasionally secondary to the irritation of a foreign body, such as an enterolith, though the circular ulceration which typifies the tubercular lesion in the lower portion of the ileum is a more common cause of obstruction. Another condition to be classed under the head of intestinal strictures which require resection is the chronic intestinal obstruction which not infrequently follows abdominal operations. Upon reopening the abdomen the small intestine may be found adherent to the peritoneal surface of the scar of the first operation.[2] It seems probable that, for an adhesion to form between the abdominal scar and a coil

[1] Moynihan, B. G. A. Abdominal Operations, 1905, p. 303.
[2] S. S. Records, Mass. Gen. Hospital, Vol. LXV, p. 83.

of intestine, some injury to the serous coat of the bowel is necessary. This would only require a slight abrasion of the peritoneum, an accident which may happen during any prolonged abdominal operation. In performing secondary operations upon animals the great omentum is invariably found fastened to the under surface of the scar of the first operation. Without doubt the protection thus afforded by the omentum prevents the intestine from becoming attached to the abdominal scar. In certain cases, when the adhesions between the intestine and the scar are extensive, chronic intestinal obstruction results. Here the lumen of the gut is constricted over an area two or three inches in length, and a complete cutting off of the passage of the intestinal contents is constantly threatened by the danger of kink formation or of swelling of the mucous membrane lining the constricted coil.

Gangrene of the intestine is usually due to interference with the blood supply. This may result from one of two causes: either from disease of the blood-vessels, themselves, or from pressure exerted on the outside of the intestine. When gangrene is associated with disease of the blood-vessels either a venous or an arterial lesion may be present, the end result being a progressive blocking of both the arterial and the venous trunks with clots which are propagated into the main vessels, thus causing necrosis of a considerable length of intestine. Examples of gangrene from outside pressure are volvulus, constriction in a hernial sac, etc.

Among the other conditions which demand a removal of a portion of the intestine are intussusception, which cannot be manually reduced; gunshot wounds, or extensive lacerations of the intestine or its mesentery; and intractable fecal fistula.

END-TO-END INTESTINAL ANASTOMOSIS.

The elementary precautions to be observed in suturing an intestine end to end differ in no way from those required for any other form of technic. Leakage of individual stitches may result from soiling of the suture line with septic intestinal contents, from bruising of the cut edges, or from inaccurate approximation of the peritoneum (Chapter II). It has become recognized as a fact, since the knowledge of Schede's[1] work has become diffused, that resection and anastomosis do not necessarily go together;

[1] Schede. Deutsch. Med. Wochenschr., 1887, XIII; Deutsch. Zeitsch. für Chir., 1901, LIX, 59.

the indications for the former may be peremptory, while the latter may be contraindicated. The presence of chronic obstruction implies a thickened bowel above the lesion, associated with more or less distention. Unless the cause of the symptoms is recognized early, the surgeon is likely to find the intestines under the influence of cathartics. Since the peristalsis is quieted by ether this contingency may be overlooked, only to find that the intestinal action is violently resumed when the effect of the anesthetic wears off. Anastomoses which are done under these conditions are subjected to a great strain by the subsequent contractions of the muscular walls of the intestines. In all but the more acute conditions, therefore, it is considered safer to perform the operation at two sittings, the first operation consisting in resecting the diseased area, with the formation of an artificial anus. After the gut has been allowed a complete rest, an end-to-end suture can be performed with the best chance of success.[1]

The studies of Monks[2] concerning drainage of distended intestines are not out of place here. In view of the well-known fact that enterostomy, done to relieve distention of the small intestine, is usually followed by the escape of little gas or intestinal contents at the time of operation, Monks made several experiments upon the cadaver. Upon opening a number of gas-distended coils he found in every case that the collapse of the gut, which followed the escape of the gas, was a purely local one, only a coil or two emptying its contents, while the rest of the intestine remained as distended as before. He came to the conclusion, as far as dead or paralyzed bowel is concerned, that the small intestine consisted presumably of various segments, not always opening freely into one another, which segments acted as separate reservoirs for gas or other contents, and that the collapse, by emptying one of them, did not necessarily mean the immediate emptying of the others. After filling the intestinal loops with water and gas it was found that the water, which occupied the most dependent portions of the loops, acted as an efficient plumber's trap, separating the different segments of the intestine. In addition to the obstacles presented by these traps in the most dependent loops, where the water collects, semisolid contents and kinks may act in the same manner. He also found that the weight of the

[1] Treves. Operative Surgery, Vol. II, p. 323.
[2] Monks, G. H. Annals of Surgery, October, 1905.

intestinal contents may press the sides of the gut so firmly together that even the pressure within the adjacent distended gut is not sufficient, without peristalsis, to open up the tube and allow the gas to pass on. A number of experiments were made to determine what lengths of intestine can be gathered on a tube when the instrument was passed through an abdominal wound of the ordinary length, and also through an opening into the gut

FIG. 89.—Showing how soon a straight instrument passed into the gut may engage its free border. (Monks.)

"such as is made in most enterostomies." Monks got the best results with a glass tube the size of an ordinary lead-pencil, the extremity of which was curved, with the opening on the concave side (Fig. 89). He found that, if the abdominal wound can be made long enough, and if the tube is of sufficient length, the greater part of the small intestine may be gathered on the tube. Moynihan[1] adopts a similar plan for drainage of the bowel in cases of ob-

[1] Moynihan, B. G. A. Abdominal Operations, 1905, p. 279.

struction. He opens the bowel on the free border and inserts a glass tube six inches long, after which he finds that he can readily draw from eight to ten feet of intestine upon a tube of this length. Elliott's[1] technic for resection and drainage is the following: After resection he immediately unites the mesenteric borders of the proximal and distal loops to facilitate the subsequent closing of the artificial anus. Care is taken to wall off the peritoneal cavity completely before allowing the contents of the proximal distended intestine to escape.

Two practical dangers are incurred in anastomosing the bowels end to end,—first, leakage from defective approximation at the mesenteric borders, and, second, a subsequent obstruction from turning in too wide an angle. Before Maunsell and Connell introduced the mattress mesenteric stitch this inaccessible portion of the circumference was fastened by means of stitches which grasped the mesenteric insertion parallel to the long axis of the bowel. The tying of these mesenteric stitches constricted the vasa recta and subjected the line of anastomosis to a not remote danger of anemic necrosis. This danger is eliminated by the use of the mattress mesenteric stitch. Post-operative obstruction at the site of the joint is caused either by taking the seromuscular stitches too far from the edge, or by reinforcing the joint with a second layer of outside stitches. A diaphragm is thus formed which may either dam the intestinal current, else, if the edge be turned in to a less degree, the bowel above the joint may be forced down by the peristalsis and caught by the diaphragm, thus resulting in an intussusception.

There are three principal methods by which an end-to-end anastomosis may be made:

(1) The Plain Anastomosis.
(2) The Mattress Anastomosis.
(3) Mechanical Devices.
  (*a*) Murphy button.
  (*b*) Harrington ring.
  (*c*) Robson bone bobbin.

Among the various methods of joining intestines end to end a few are to be described in detail which are in wide use at the present time.

[1] Elliot, J. W. Annals of Surgery, November, 1905.

Mechanical devices may have had their day; they certainly have proved of the utmost value during the evolutionary period of gastrointestinal work. But a large number of surgeons still prefer such instruments as the Murphy button, the Harrington segmented ring, and the Robson decalcified bone bobbin. Since there is a demand for mechanical aids in the surgery of the intestinal tract, the author has thought it wise to explain the best and the simplest methods of technic required for their use.

The plain anastomosis with two layers of stitches has already been discussed at length. In the opinion of the majority of operators this technic includes all of the essential requirements for this work. The accepted advantages of the Connell mattress anastomosis are two: (1) The union gains great strength by the penetration of each stitch through every coat of the bowel. These stitches do not pull out if snugly tied, because the pull is all sustained by the loop, which, being placed across the muscle-fibers, cannot cut out through the lines of muscular cleavage. (2) This stout grip of the mattress stitches allows their being introduced very close to the cut edge of the bowel, so that practically no inversion results. It is not possible to decide between the plain and the mattress anastomoses on the ground of leakage dangers, for an accurate observance of the special points of either technic should give a safe joint. It is evident, however, that the most satisfactory work will be done by the operator who confines himself to one of these methods, without attempting to become equally familiar with all.

PLAIN END-TO-END ANASTOMOSIS.

Steps:

(1) Clamps.
(2) Resection.
(3) Mattress mesenteric stitch.
(4) First two guides to mesenteric border.
(5) Continuous suture of circumference through all coats.
(6) Seromuscular stitch, interrupted, or continuous.
(7) Approximation of cut mesenteric edges.

The coil of intestine to be resected is withdrawn from the abdomen, and, to avoid subsequent soiling of the wound, the intestinal contents are pushed to either side by stripping with the fingers. Clamps are then applied

to the intestine, at a right angle to the lumen, leaving a margin of about three inches on either side of the area to be cut out. A good instrument to use for this purpose is the straight circumcision clamp, the jaws of which have been covered with rubber tubing. Finally, a handkerchief gauze is wrapped around the intestines beneath the clamps to isolate the field of operation from the abdomen. To prevent spilling out of whatever contents are left in the resected portion, clamps or circular ties will be required. If no intestinal clamps are at hand, straight half-length clamps may be used, without covering. In resecting the bowel, there is always vigorous bleeding from the terminal branches of the small vascular arches which run parallel with the bowel, near the mesenteric attachment,—*i. e.*, the vasa recta. These vessels are best tied double and cut before opening the intestine, including as little as possible of the mesenteric fat. The coil is now grasped by the fingers of an assistant, about an inch on either side of the point at which the incision is to be made, and the operator cuts carefully with a knife through all coats of the bowel, wiping away the blood and the intestinal contents with the left hand. It is better to finish the resection with scissors, in order to watch each side as it is cut away (Fig. 90).

It has become traditional to cut away the bowel obliquely to make sure of the blood supply at the free edge (Madelung[1]). A slight obliquity is necessary to allow for the excess of inturned edge at the mesenteric border. Sloughing of the joined edges will not occur, however, if the mattress mesenteric stitch is used, although, as mentioned before, the old method of joining the mesenteric edges with stitches taken parallel with the bowel wall may cut off the circulation and cause anemic necrosis of the joined edges. The incision is finally continued down through the mesentery for two or three inches, avoiding the evident vessels and tying when necessary. Finally, the narrow pedicle of mesentery which remains is tied off and cut, which completes the resection. Of the several ways of treating the mesentery shown in Fig. 91, the best is the removal of a wedge-shaped piece, as described in the text.

The placing of the Maunsell mesenteric stitch forms the starting-point of the anastomosis. This should enter and leave the bowel a little more

[1] Madelung, O. Verhandl. der Deutsch. Gesellsch. für Chir., Berlin, 1881, x, pt. 2, pp. 414–464; Archiv für Klin. Chir., Berlin, 1881–2, xxvii, pp. 277–326.

than one-eighth inch from the cut edge, but should penetrate the mesenteric space and the peritoneum farther forward. This furnishes an ample width of edge for the subsequent continuous catgut stitch, without separating the bowel edges with a thick mass of fat (Fig. 92). The mesenteric third of the bowel circumference is rather inaccessible, and, to bring this portion forward, guide stitches are introduced. The scheme for developing the mesenteric border with the first two guides was originally described by Jaboulay and Briau,[1] but, as their method of placing the inner layer of stitches is out of date, it has been here modified to include all the recent technical improvements. To control hemorrhage, and to bring the cut edges together, a continuous chromic catgut stitch is used, size preferably No. 0. This stitch starts a short distance to one side of the mesenteric border, where it is tied outside of the bowel, leaving a long end to be used for the first guide. A second guide is next placed on the opposite side of and at an equal distance from the mesenteric border, with its ends left inside, to invert the bowel edges. The distance between the two guides should equal, approximately, one-third the circumference. Upon tightening the guides the cut edges between the two are exposed, and the continuous through-and-through stitch passes across from one guide to the other (Fig. 93). When the second guide is reached, a third guide is introduced half-way between the first two, on the free edge of the bowel, opposite the mesenteric attachment. The ends of this guide are left outside. Traction on this, and on the lower guides, will make easy the completion of the continuous stitch (Fig. 94). The end of the continuous suture left after circling the circumference is tied to the long end left on the first knot, and the guides removed. The continuity of the chromic stitch must be broken occasionally by knots, so as to make it difficult to narrow the lumen by drawing the catgut into a purse-string, and, also, to give greater security to the joint.

The most important step in the anastomosis is the seromuscular suture. Both continuous and interrupted stitches are employed for this purpose, but the Lembert stitch is on the whole more reliable. The first interrupted seromuscular stitch is placed on the free edge, opposite the mesenteric border, and is followed by a stitch at the mesenteric border on either side. The ends of these three stitches are left long, as they make excellent guides for

[1] Jaboulay et Briau. Lyon Médical, 1896, T. LXXXI, 19 Avril, p. 529.

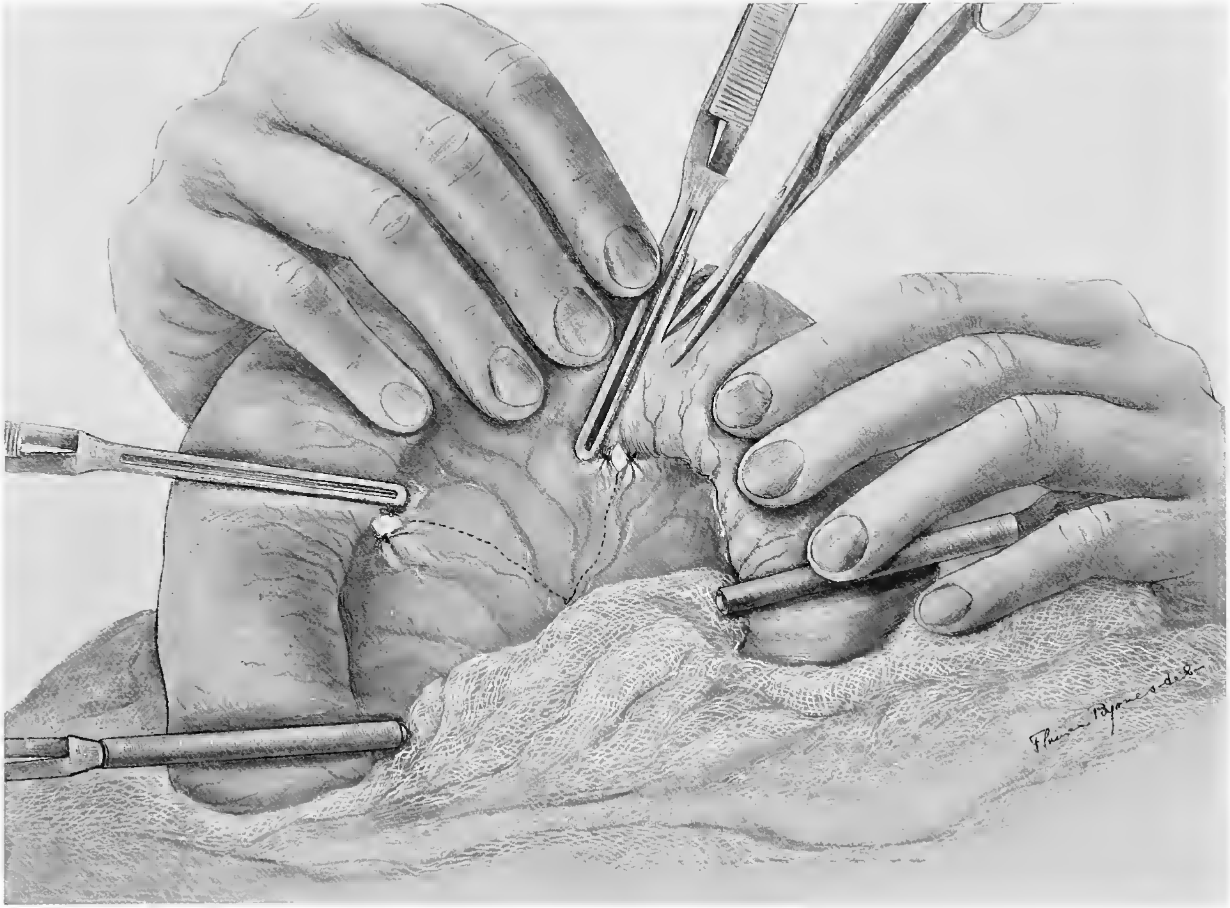


FIG. 90.—END-TO-END INTESTINAL ANASTOMOSIS.

This figure shows the method of performing the resection both for the plain and the mattress anastomoses. Note assistant's method of holding the gut; plan of application of clamps; walling-off gauze, and use of scissors.

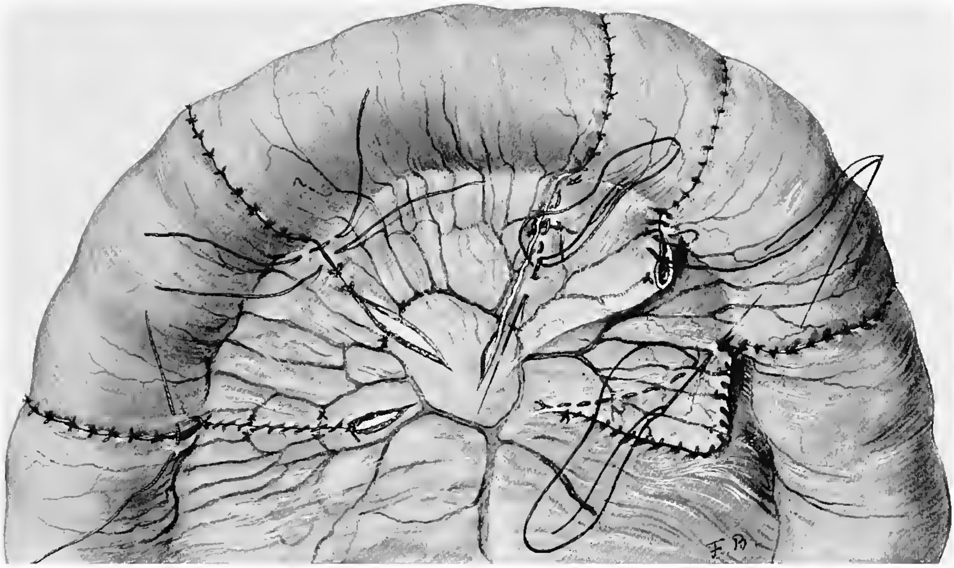


FIG. 91.—This figure shows several methods of sewing together the cut mesenteric edges after resection of the bowel. None of the methods need explanation except the last two on the right, where the bowel has been cut away without removing the usual V of mesentery. The redundant mesentery is folded on one side and tacked down to the mesentery on three sides. (Redrawn from Bickham.)

FIG. 92.—END-TO-END ANASTOMOSIS.
Mattress mesenteric stitch.

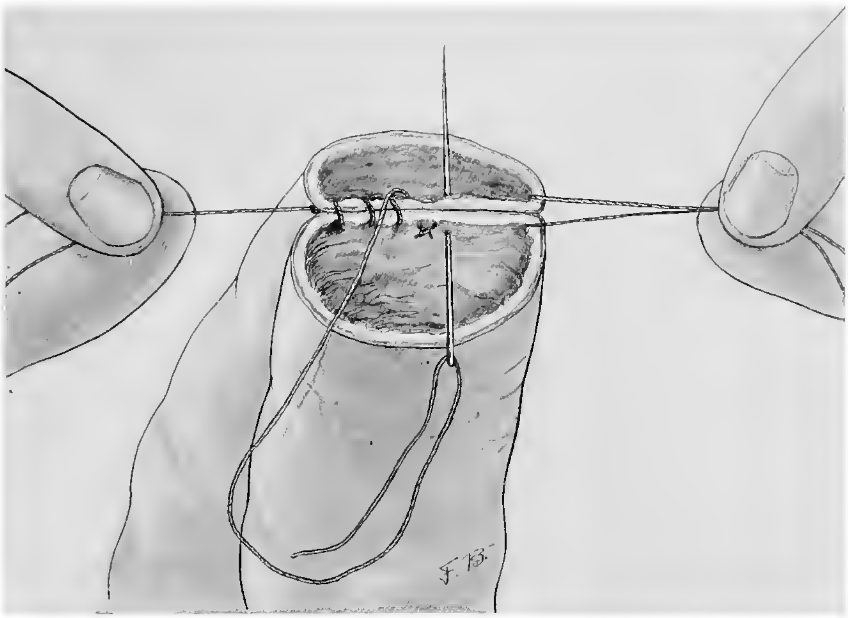


FIG. 93.—END-TO-END ANASTOMOSIS.

Sewing mesenteric third of circumference. Guides are held by an assistant. The guide on the left is merely the long end left at the beginning of the continuous over-and-over stitch.

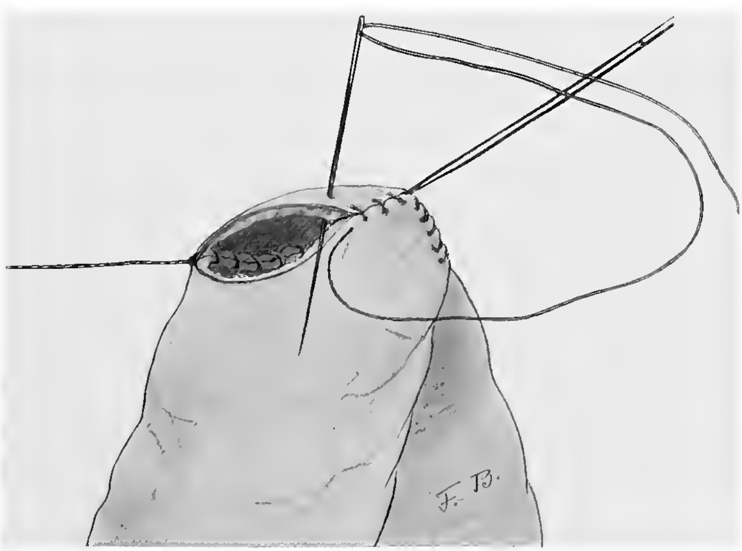


FIG. 94.—END-TO-END ANASTOMOSIS.

Closing in the last third of the circumference. The guide on the right has been placed at a point opposite the mesenteric border. The guide on the left is the original long end left at the first knot, and was also used as a guide in sewing the mesenteric third.

the remaining stitches, which are introduced in the usual way (Fig. 95). The

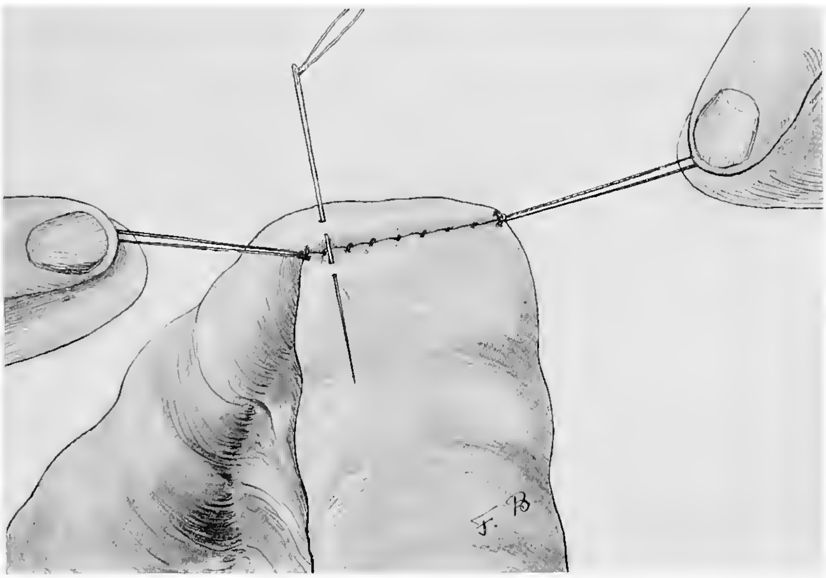


FIG. 95.—END-TO-END ANASTOMOSIS.

Placing the interrupted Lembert stitches. Two interrupted stitches have already been placed at the free and the mesenteric borders respectively. These first two stitches are used as guides to assist in the introduction of the remaining interrupted stitches.

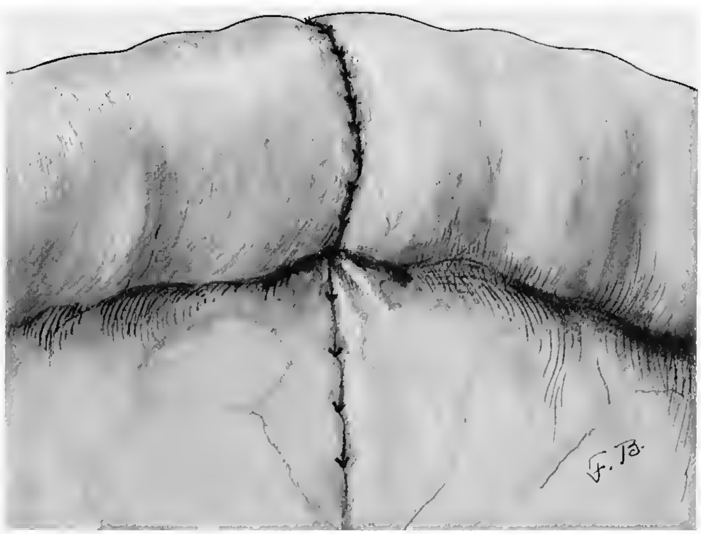


FIG. 96.—END-TO-END ANASTOMOSIS.

The suture has been completed. The cut edges of the mesentery have been sewed together with interrupted stitches.

mesentery is, finally, caught together with a few interrupted stitches (Fig. 96).

When doubt exists about the ability of the stitches to hold the joint tight, it is possible to reinforce the suture line by grafting a bit of omentum over the spot in question (Fig. 97, after Bickham). The following technic is recommended by Senn for this procedure: A piece of the great omentum, of the proper shape and size to cover the suture line, is cut off with scissors. Senn immerses the grafts in saline solution and, later, presses them out before fastening them in place. If the experience obtained in skin-grafting can be applied to omental grafting, the soaking of the grafts is a disadvantage, as it deprives the tissues of blood (Porter). It is better that the

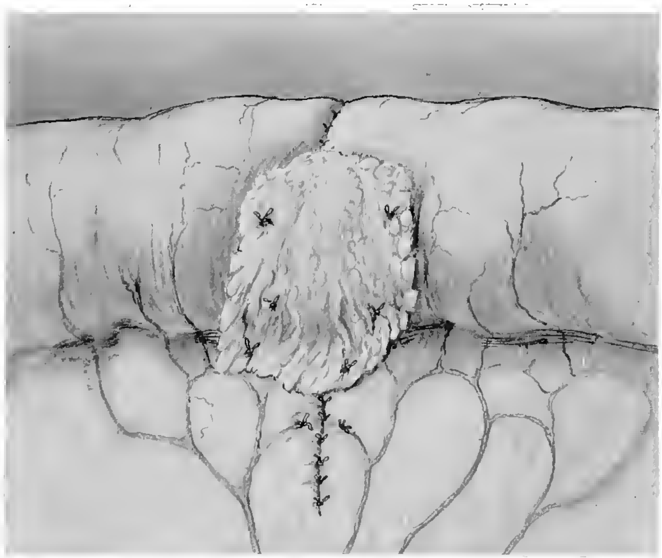


FIG. 97.—OMENTAL GRAFT. (After Bickham.)

grafts be touched as little as possible before attaching them in place, since any considerable handling must destroy their vitality. In my experimental work upon repair, several sections were obtained in which adhesions were present between the omentum and the suture line; in one case only was the omentum attached intentionally, and then without cutting it off from its blood-supply. In these sections the process of repair appeared to have advanced more rapidly between the intestine and the omentum than between intestine and intestine at the line of anastomosis.

If deductions can be drawn from animals, where the repair is very

active, grafting, on the whole, is not desirable, because the graft becomes fastened to the neighboring intestinal coils, as well as to the suture line. As a consequence, a mass of tangled adhesions may tie together several loops of intestine.

Senn[1] states that the adhesions between omental grafts and intestinal serosa seemed denser when the serosa had been prepared by gentle scoring. This stimulates an exudation of serum, and, for this reason, was adopted by Senn as a part of his technic.

The grafts are fastened in place by a few soluble interrupted stitches.

END-TO-END ANASTOMOSIS BY THE MATTRESS STITCH.

This anastomosis is known as the method of Connell.[2] It is an effective adaptation of the mattress stitch to end-to-end anastomosis.

Steps:

(1) Three mattress stitches to the mesenteric border.
(2) Mattress guides develop one-third of the circumference.
(3) Mattress stitches to first third.
(4) Mattress guide to adjoining third of circumference.
(5) Second third of circumference everted and sewed from inside with mattress stitches.
(6) Second third allowed to retract, and last third of circumference sewed from outside.
(7) Last stitch, Cushing mattress.
(8) Approximation of cut mesenteric edges.

The mattress mesenteric stitch is introduced as before described. It was explained under the technic of the plain anastomosis that it is always best to complete the mesenteric portion of the joint before closing in the remainder of the circumference. For this reason it is desirable to place a mattress stitch on either side of the usual mesenteric stitch before proceeding with the rest of the suture. This point was suggested by Coffey in his technic. The second and the third mesenteric mattress stitches should be placed so close to the first that their inner halves also include a portion of the mesentery (Fig. 98). One of the two outer mesenteric stitches is left long for future use as a guide. The next step is to develop

[1] Senn, N. Practical Surgery, 1901, p. 821.
[2] Connell, F. G. Philadelphia Monthly Med. Journal, Vol. 1, 1899.

the cut edges of the first third of the bowel circumference. To do this, two mattress guides are necessary, the first being placed on the side of the intestine, at a distance from the mesentery which corresponds to one-third the bowel circumference, while for the second guide the outer of the three mesenteric stitches is utilized, the ends of which have been previously left long.

In Fig. 99 the guides are taut, thus bringing forward the cut bowel edges. The anastomosis depends wholly upon one layer of through-and-through mattress stitches, introduced one-eighth inch from the edge, and tied on the inside, as described in Chapter II. It is critical that the stitches

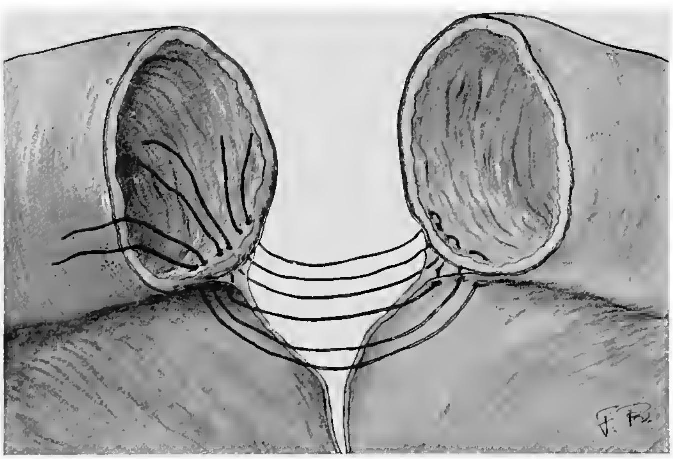


FIG. 98.—END-TO-END ANASTOMOSIS, CONNELL MATTRESS.
Shows method of placing the three mattress mesenteric stitches. For the sake of clearness these stitches have not been tied, although, actually, each stitch should be tied as soon as it is introduced.

be placed close together, else bleeding may occur from the cut edges between stitches. Connell advises that the interval be not over one-eighth inch. After completing the suture of the first third of the circumference, the mesenteric guide is cut short, and a third mattress guide introduced, at a distance from the second guide equal to one-third the circumference. After tying this guide-stitch, the long ends of the second guide are passed beneath this third guide. Traction upon the second and the third guides will turn the mucous surface of the intestine outside in such a manner that the second third of the circumference is brought forward, thus allowing the edges to be easily sewed from the inside with interrupted mattress stitches (Fig. 100).

The second guide is now cut, and the everted portion allowed to retract inside, leaving a small space to be closed in. It is possible, by placing the second and the third guides very wide apart, to sew together three-fourths the circumference of the intestine from the inside. At present Connell sutures the circumference by halves instead of by thirds, a modification which is made possible by placing the guides wide apart, as just stated.

The last portion to be closed in, between the third guide and the mesenteric border, is done as follows: The assistant holds the two coils side by

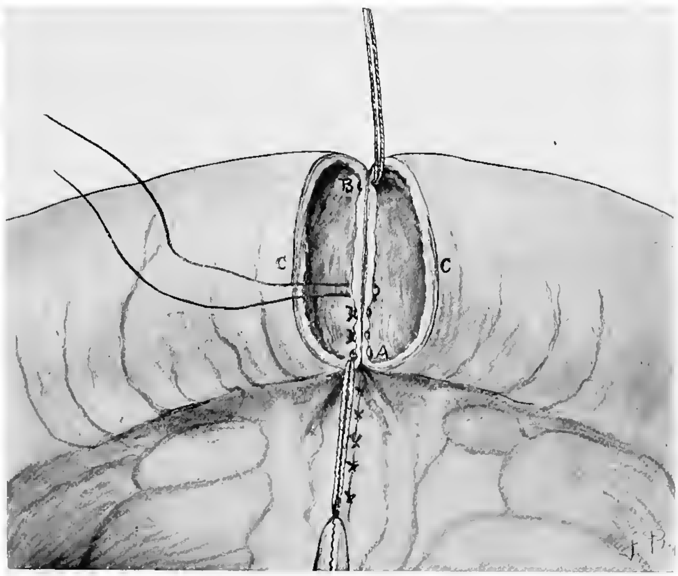


FIG. 99.—END-TO-END ANASTOMOSIS, CONNELL MATTRESS.

First third of bowel circumference developed by guides A and B. The intervening space is being closed with interrupted mattress stitches. Guide A is the outer mesenteric mattress stitch. Guide B marks the first third of the circumference. The point C designates the site of the third mattress guide.

side between the thumb and the middle finger of the left hand, the first finger being placed between the two coils and under the suture (Fig. 101). The right hand draws down on the long end, which is always left on the last stitch, thus rolling in the cut edges, as the new stitch is being placed. When the stitch has been tied, the one just used as a guide is cut short, and the last stitch taken is left long, with which to invert the edges for the next stitch (Scudder). Although the stitches which approximate the last third of the circumference penetrate the bowel edges in exactly the same

[1] Scudder, C. L. Unpublished communication.

manner as those of the first two-thirds, yet, from the point of view of the operator, they seem to be reversed. For this reason it will be well to bear in mind that (1) the needle always starts from within the lumen; (2) the needle always goes from mucous membrane to peritoneum, and from peritoneum to mucous membrane, or, m-p-p-m.

It is not possible to tie the last stitch without resorting to some expedient to assist in turning in the peritoneum. Connell overcomes the difficulty as follows: The blunt end of a needle is inserted between two stitches

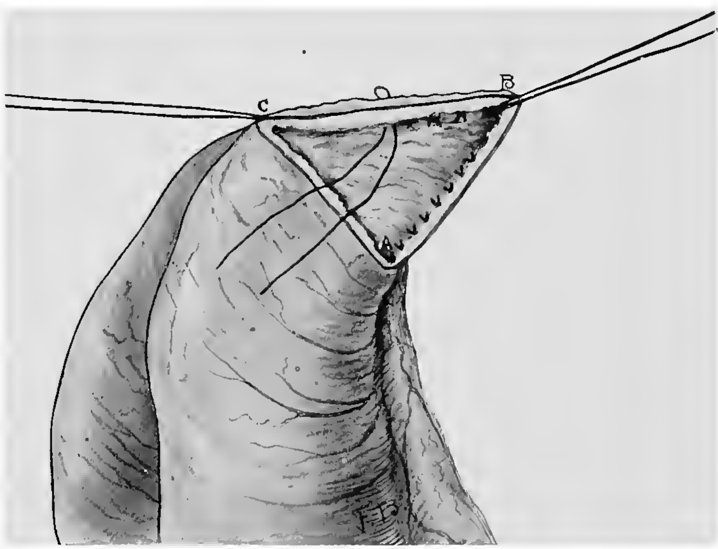


FIG. 100.—END-TO-END ANASTOMOSIS, CONNELL MATTRESS.

Guides B and C develop the second third of the circumference, their points of introduction being shown in Fig. 99. The circumference has been turned inside out by passing guide B beneath guide C, and drawing tight the two ends, thus allowing the second third of the circumference to be sewed from the inside.

at a distance from the stitch about to be tied, and the eye pushed up until it emerges through the space to be closed in by the last stitch. Both ends of this stitch are threaded through the eye and are drawn out with the needle until the free ends can be grasped outside the bowel. Here the ends are tied and the knot allowed to retract into the lumen. This finishes the suture, but many surgeons find it simpler to close in the last gap with a Cushing mattress stitch, as shown in Fig. 102, than to adopt the rather difficult suggestion of Connell. When well done, this anastomosis gives a

very strong, artistic joint, because the stitches penetrate all coats, and, when tied, do not show on the outside.

MECHANICAL DEVICES.

Mechanical devices are used for two purposes: (1) for speed, (2) as a support to hold the cut edges in place during the introduction of the outer

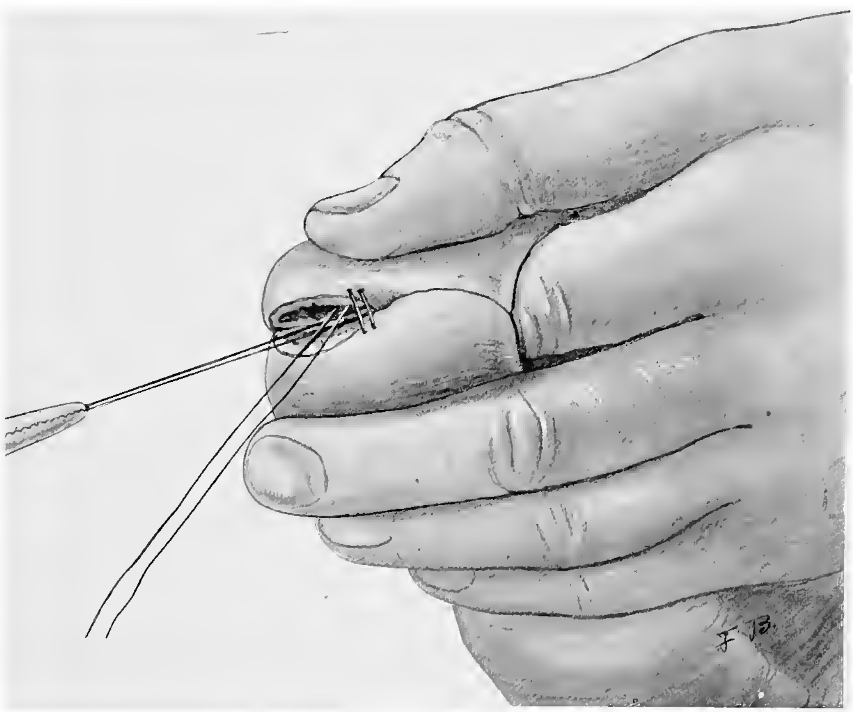


FIG. 101.—END-TO-END ANASTOMOSIS, CONNELL MATTRESS.

The everted bowel edges have been replaced and the last third of the circumference is now being closed in by mattress stitches, which are apparently reversed. Note that traction on the long ends left on the previous mattress stitch inverts the cut bowel edges, and thus assists in tying the next stitch. Note also method of holding the bowel by assistant.

layer of stitches. Three devices are described below which contain practically all the advantages of mechanical aids. Although these instruments actually do gain time, in the hands of experienced operators, they should not be chosen for the apparent simplicity of their use. Each requires an accurate knowledge of what the instrument can do, and the technic is based upon this experience.

The Murphy[1] button is used mainly for speed, and offers a very rapid method for end-to-end or for lateral anastomosis. It is not necessary to give a careful description of the device, since its every feature is perfectly familiar to all. In using the Murphy button the operator must place the patient's life in the hands of the instrument-maker, for slight imperfections in construction have repeatedly resulted in separation of the button halves and leakage of the joint. The instrument has been modified in several particulars since it was originally introduced, the improvements being directed chiefly toward increasing the lumen of the inner tube.

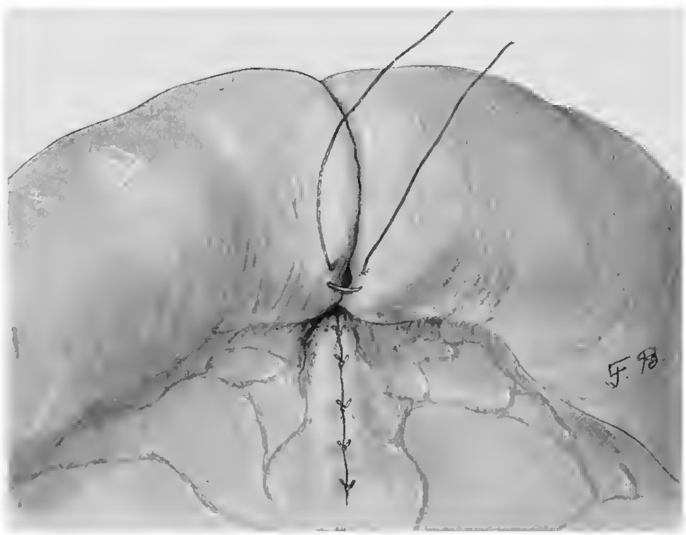


FIG. 102.—END-TO-END ANASTOMOSIS, CONNELL MATTRESS.
Introduction of last stitch, ends tied on the outside.

Steps:

(1) Clamps.
(2) Purse-strings.
(3) Resection.
(4) Introduction of button halves.
(5) Tying purse-strings.
(6) Halves of button snapped together.
(7) Sewing of mesentery.

[1] Murphy, J. B. Chicago Med. Recorder, December, 1892; New York Med. Record, December 14, 1892.

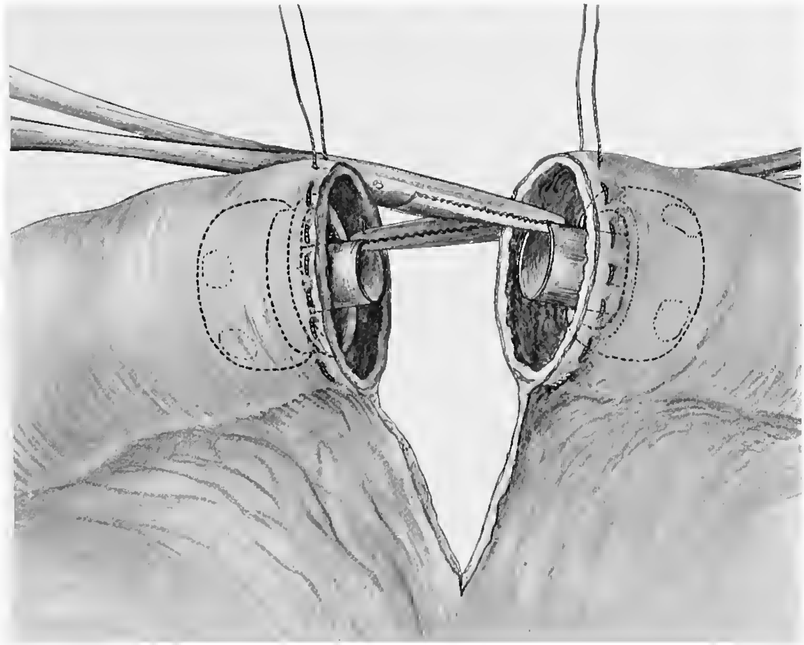


FIG. 103.—END TO-END ANASTOMOSIS.

Introduction of the Murphy button. Note purse-string sutures, and clamps on button halves.

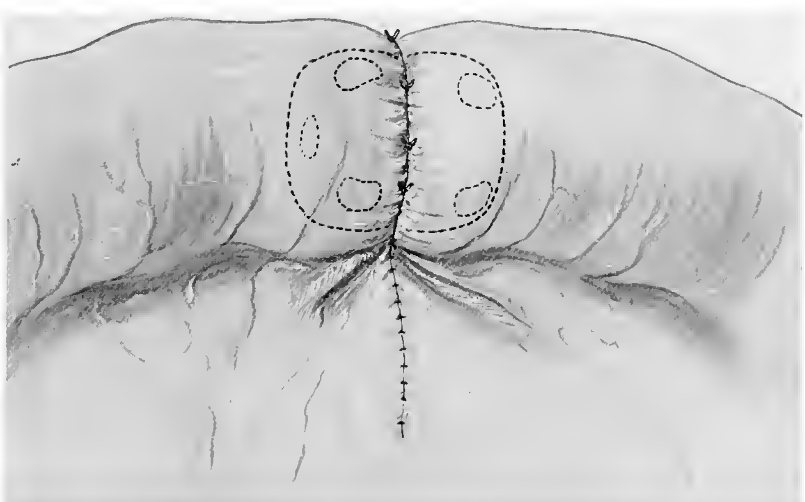


FIG. 104.—END-TO-END ANASTOMOSIS, MURPHY BUTTON.

The button halves have been snapped together and the joint reinforced with a few interrupted stitches.

The application of the clamps is made in the same manner as in other end-to-end anastomoses. The purse-strings should be of soluble material, preferably No. 2 plain catgut. These sutures are introduced after the method shown by Figs. 56, 57. A good margin is chosen on either side of the area to be resected and the purse-string placed, a half-knot being tied in the loose ends to save time later. The area to be removed is now clamped off and the incisions made on the outer side of either clamp up to one-eighth inch of the purse-strings. The removal of the resected portion with its mesentery has been described under the plain suture. The unscrewed halves of the button are seized with artery or special forceps, inserted into the open bowel lumina, and the purse-strings tied down to the male and the female tubes (Fig. 103). The forceps are then removed by an assistant while the surgeon grasps the bowels close behind the button halves to prevent their slipping back inside. The completion of the anastomosis is accomplished by invaginating the male tube of one-half into the female tube of the other, and thus forcing the peritoneal coats into tight apposition (Fig. 104). The button is provided with a spring which will make allowance for a certain amount of irregularity in the joined surfaces; but the mesenteric border will always remain a weak spot. This will be recognized when it is remembered that the purse-string, by its inversion of the bowel ends, draws with it a portion of the mesentery. Since this thick wad of fat must be crushed before the joint can be made tight, it is safer to put in an occasional interrupted stitch before closing the abdomen. When used for lateral anastomosis, the button is placed between layers of equal thickness, as the operation is done at a distance from the mesenteric border. Here the joint can be made perfectly tight without danger of leakage. In choosing a button for this work, an exigent examination must be made of the spring and the screw-thread to make certain they are perfect. This is especially true when the button has been previously used. It is to be remembered that this instrument stays in place at least eight days, and usually much longer. Its transit through the small intestine is attended with vigorous peristaltic action and thus renders the convalescence rather uncomfortable.

The Harrington Segmented Ring[1] and the **Robson Decalcified**

[1] Harrington, F. B. Boston Med. and Surg. Journal, November 6, 1902.

Bone Bobbin[1] are constructed upon the same principle, their object being to gain speed, without sacrificing the advantages of the seromuscular stitch. Both of these instruments are reduced in size before they pass on,—the ring by segmentation, the bobbin by solution. For this reason they cause no discomfort from increased peristalsis. The ring is made of hard aluminum in four sections. These sections are jointed firmly together by a small bar of steel which has a shoulder and a screw-thread, and which serves as a handle. The outer surfaces of the ring are grooved to hold the ends of the intestines, which are tied in place by catgut purse-string sutures. The segments fit together by means of sliding tongue-and-groove joints so rounded that they will not cut or catch in the tissues. The ring is made in three sizes.

Diameter.	*Width.*	*Wt. of individual segments.*
$\frac{5}{8}$ inch	$\frac{1}{2}$ inch	10 grains
$\frac{7}{8}$ "	$\frac{5}{8}$ "	20 "
$1\frac{1}{8}$ "	$\frac{5}{8}$ "	30 "

The bobbin, as described by Robson,[2] is "nothing more than a cylinder of decalcified bone with raised ends." It is made in many sizes for adap-

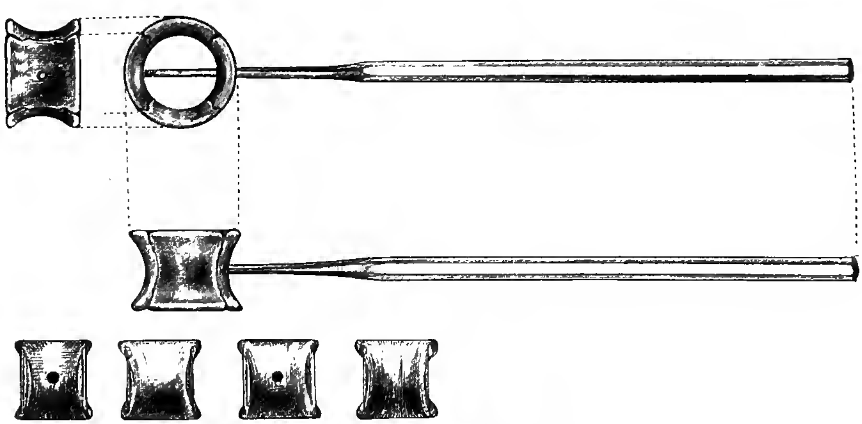


FIG. 105.—END-TO-END ANASTOMOSIS, HARRINGTON SEGMENTED RING.
Actual size of smallest ring.

tation to a large variety of operations, from cholecystenterostomy to end-to-end suture of the large intestine. Although the bone bobbin is a suc-

[1] Robson, A. W. Mayo. Brit. Med. Journal, 1893, April 1, 1, 688, 689; Sém. Méd., Paris, 1892, XII, 485.

[2] Robson, A. W. Mayo, and Moynihan. Surgical Treatment of Diseases of the Stomach, 1904, p. 233.

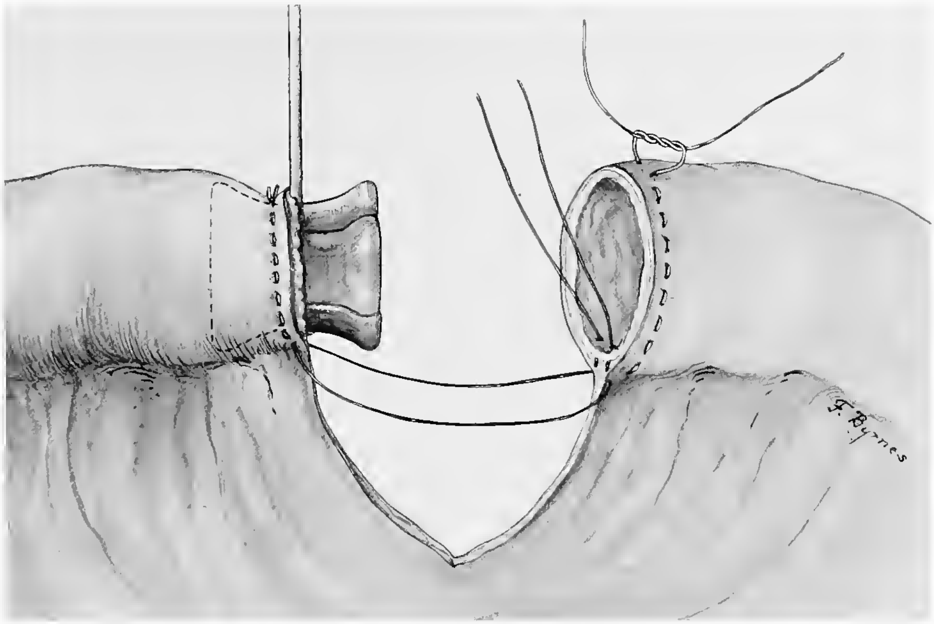


FIG. 106.—END-TO-END ANASTOMOSIS, HARRINGTON'S SEGMENTED RING.
Purse-strings, one tied, about ring. Mattress mesenteric stitch loosely placed.

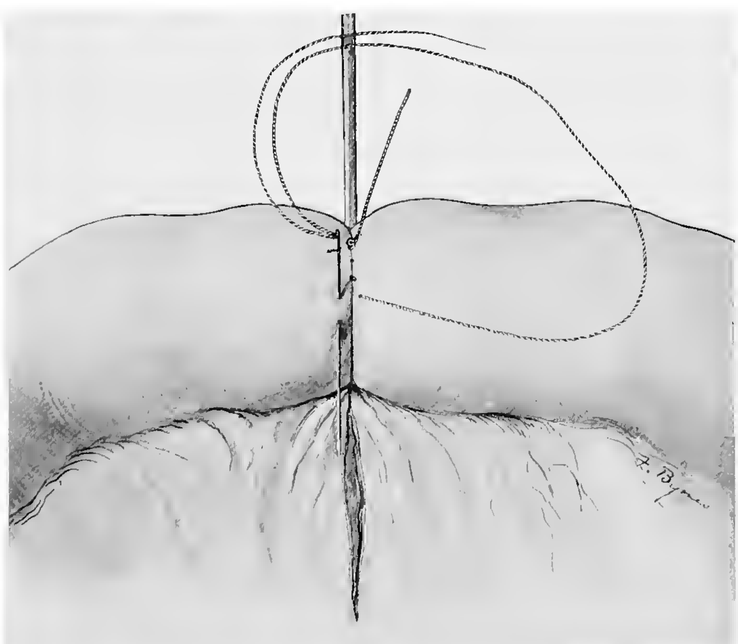


FIG. 107.—END-TO-END ANASTOMOSIS, HARRINGTON'S SEGMENTED RING.
Continuous seromuscular suture around circumference of joint.

cessful device, yet the necessity of keeping it in alcohol renders it rather inconvenient to carry about. The segmented ring can be carried in the layout with the other instruments and boiled (Fig. 105).

Steps for the Ring and the Bobbin:

(1) Purse-strings.
(2) Resection.
(3) Mattress mesenteric stitch.
(4) Introduction of instrument.
(5) Tying of purse-strings.
(6) Tying of mesenteric stitch.
(7) Continuous seromuscular stitch about joint.
(8) Removal of handle (ring).
(9) Approximation of cut mesenteric edges.

The first two steps are identical with the beginning of the button technic; but, with these instruments, we are able to fasten the mesenteric borders of the gut securely by means of the Maunsell mattress stitch, described in the plain suture and elsewhere. This stitch is placed immediately after the resection has been done, and is loosely tied with a half-knot to save time later. The material for this stitch should be No. 0 chromic gut. After the mesenteric stitch is placed, the device is slipped into the ends of the open bowels, and the purse-strings tied (Fig. 106). The mesenteric stitch is then made fast, thus completing the preliminary steps of the operation. The mainstay of the suture is the seromuscular continuous stitch. This brings the circumference of the bowels together and turns in the edges which are bound down to the instrument (Fig. 107).

In employing his bobbin for lateral anastomosis Robson does not use a purse-string, a method which is applicable to end-to-end union. In this technic one-half of the outer seromuscular stitch is first placed. The cut edges are then sewed together from the inside with a continuous catgut stitch, leaving just enough room for the introduction of the bobbin. When the bobbin has been slipped into the lumen the through-and-through continuous catgut stitch is carried over the front and tied, after which the seromuscular stitch is taken up and the peritoneum closed over the last half of the circumference.

FORMATION OF A BLIND END.

It is occasionally difficult, or even impossible, to suture two cut intestinal ends in continuity. Such is frequently the case when it becomes necessary to anastomose the ileum to the colon after resection. At other times the character of the operation demands that the intestines be joined side by side, or else by planting the end of one into the side of another. As a preliminary step to the lateral anastomosis, a safe method is required for closing the cut ends. Two methods are given:

(1) Suture in two layers (old).

(2) Purse-string.

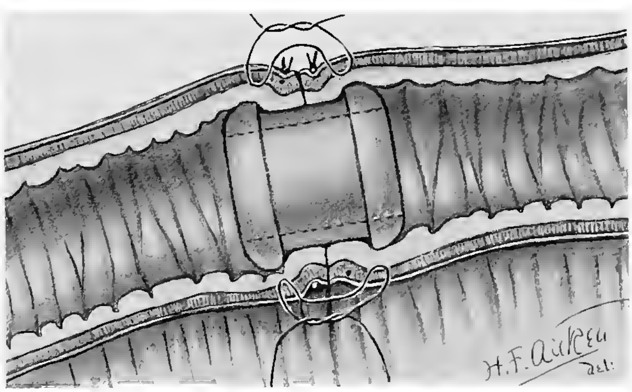


FIG. 108.—END-TO-END ANASTOMOSIS, ROBSON'S DECALCIFIED BONE BOBBIN.
Two layers of sutures: inner, purse-string; outer, seromuscular. The outer stitch is in reality continuous, although shown diagrammatically as interrupted.

SUTURE IN TWO LAYERS.

This is the classical technic. It is slightly modified here by the addition of the reversed mattress stitch. This method is especially indicated in closing in the large intestine, since the edge turned in is a very narrow one. The purse-string, or second method, may be used on the large intestine when plenty of leeway can be left between the puckered end and the second joint; otherwise the routine suture in two layers should be adopted.

Steps:

(1) Clamps, and resection.

(2) Continuous inner stitch to bowel and mesentery.

(3) Interrupted mattress stitch to peritoneum.

The clamps are applied and the resection done as usual. The intestine is closed with two layers of stitches. The inner is a continuous through-and-through suture, which starts at the free edge of the bowel, and approxi-

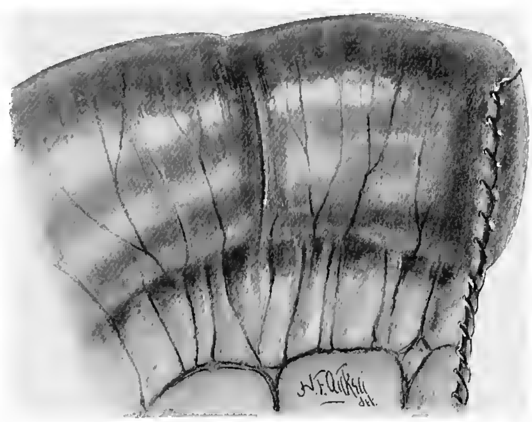


FIG. 109.—FORMATION OF BLIND END (old).
Inner continuous Glover's stitch to bowel and mesenteric edges.

mates the cut edges from above downwards. When the mesentery is reached the stitch is continued down over it, thus securing any small vessels which have been cut during the resection (Fig. 109). The outer sero-

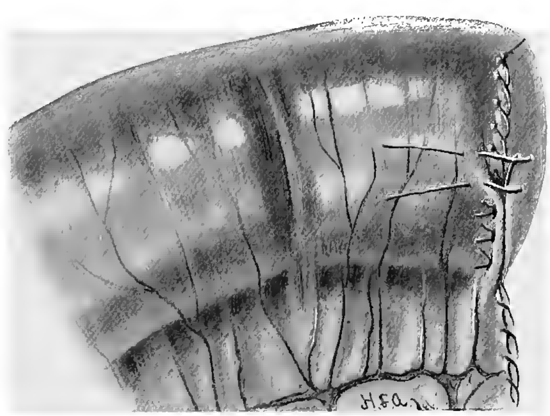


FIG. 110.—FORMATION OF BLIND END (old).
Outer layer of reversed mattress stitches.

muscular layer of stitches may be either interrupted or continuous. A strong close approximation is obtained by applying the reversed mattress stitch, as shown in Fig. 110.

THE PURSE-STRING OPERATION.

This operation has been developed and improved by various American surgeons. The originators of the technic were Doyen,[1] Bardenheuer,[2] Winiwarter,[3] and others. This is a very rapid and safe method. Its main disadvantage consists in the wide edge of bowel which is invaginated by the purse-string. In situations where the width of the turned-in edge is of no consequence the technic is perfectly satisfactory. It is commonly used for closing the duodenum after pylorectomy (Mayo).

Steps:

(1) Purse-string suture.
(2) Clamp.
(3) Resection.
(4) Cut edges sewed with through-and-through catgut suture.
(5) Clamp removed.
(6) Invagination of sewed-over cut edges, with tying of purse-string.
(7) Interrupted stitches to end of bowel.

If possible, the purse-string should be placed before opening the bowel. In this instance an insoluble stitch is desirable because the purse-string is the mainstay of the joint and is used to bring together the serous coats. A clamp is now placed across the intestine, about one-quarter inch from purse-string, on the side of the proposed resection. For this purpose a straight half-length clamp is usually large enough, although sometimes a longer clamp may be necessary. The jaws are not protected by rubber, as the portion of the bowel grasped by them will be turned in. The intestine is next cut away with scissors, leaving an edge of one-quarter inch attached to the clamp. In order to add security against an accident to the purse-string and to control the bleeding, the cut edges are sewed together with a through-and-through soluble stitch extending from the free edge well down over the triangular mesenteric space (Fig. 111).

The clamp is now removed and the circumference of the bowel grasped

[1] Doyen. Chirurgen Congress Verhandlungen, 1898, p. 200.

[2] Bardenheuer. Experimentelle Beiträge zur Abdominal-Chirurgie, Inaugural Dissertation, 1888, p. 68.

[3] Winiwarter. Verhandlungen der Deutsch. Gesellsch. für Chirurgie, 1891, 1, 133.

with the left hand, while the right invaginates the sewed-over cut edges with forceps. When the rough edges have been tucked in in this manner the purse-string is drawn tight and tied by the assistant, thus closing the

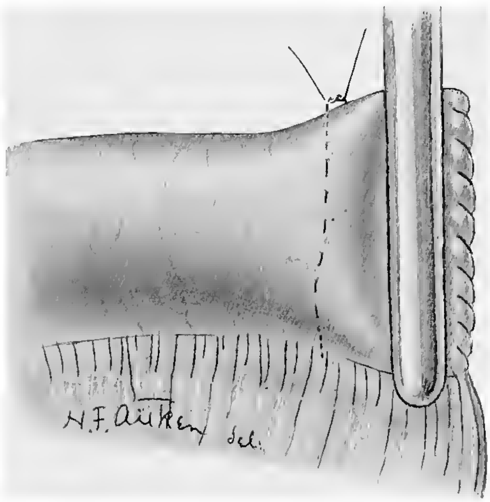


FIG. 111.—FORMATION OF BLIND END.

Fig. 111 shows purse-string in position with ends lightly tied in a half-knot. The cut intestinal end is grasped between the jaws of a clamp while the edges are sewed together with an over-and-over stitch through all coats.

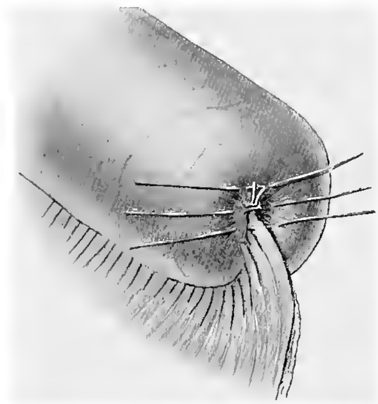


FIG. 112.—The sewed-over cut edges have been invaginated, and the purse-string tied. Note how the mesentery is drawn up into the dimple; also note the reinforcing interrupted stitches (seromuscular).

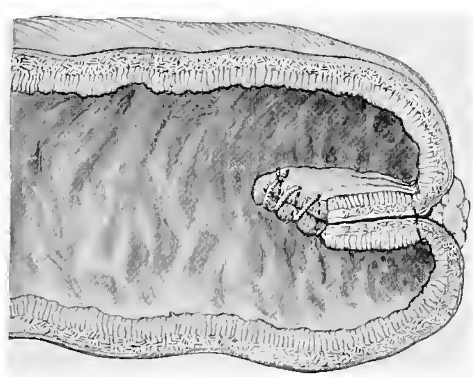


FIG. 113.—FORMATION OF A BLIND END. Cross section.

bowel end. The tightening of the purse-string draws up part of the cut edge of the mesentery, and thus fills the dimple resulting from the puckering-in with a thick plug of fat. As an extra precaution, a few seromuscular stitches are added. When a lateral anastomosis is to be done (by Abbe's

method[1]) the two cut ends must be closed by the above technic; when an end-to-side, only one blind end need be made (Figs. 112, 113).

LATERAL INTESTINAL ANASTOMOSIS.

This operation consists in joining two intestinal coils, or the intestine and the stomach side by side, with the establishment of a fistulous opening between the attached organs. It was devised for the purpose of conducting the intestinal stream around an obstruction when resection was contraindicated. It is now used for many conditions where no obstruction is present. The following are the methods used for performing the lateral anastomosis:

(1) Plain suture.
(2) Mattress suture.
(3) Mechanical devices.
  (a) Jaboulay's button; ring; bobbin.
  (b) McGraw rubber ligature.

PLAIN SUTURE.

This is considered the safest and best technic.

Steps:

(1) Clamps.
(2) First seromuscular stitch.
(3) Intestine opened.
(4) Through-and-through continuous stitch.
(5) Seromuscular stitch continued over front of joint.

A fold, about three inches long, is picked up on the free edge of the bowel with the fingers of the left hand. The clamp pinches in this fold, with care to include only just enough to allow the suture to be done. The constant secretion of mucous from the inside of the opened gut makes it desirable to have as little as possible of the mucous membrane exposed during the operation. If the cut bowel ends have been previously turned in, the clamps should allow a good margin, to avoid contusion of the closed ends (Fig. 114).

The actual suture is done in two layers: (1) the inner continuous, through-and-through of all coats, and (2) the outer seromuscular. It is

[1] Abbe. Medical Record, 1892, Vol. XLI, p. 365.

more convenient to place the first half of the seromuscular stitch before opening the bowel, for, in this manner, the two coils are steadied together, while opening the gut and placing the inner stitches. The first continuous stitch is placed longitudinally, about one-fourth inch from the free edge of the bowel extending over a distance of about four inches. The thread is left long at each end of the suture, especially at the last knot, since this long end is to be used later to cover in the front of the joint. The incisions into the bowels are made longitudinally, and exactly opposite the mesenteric borders. The cuts are best made with long, free strokes of the knife, and should be about one-eighth inch shorter at each end than the first con-

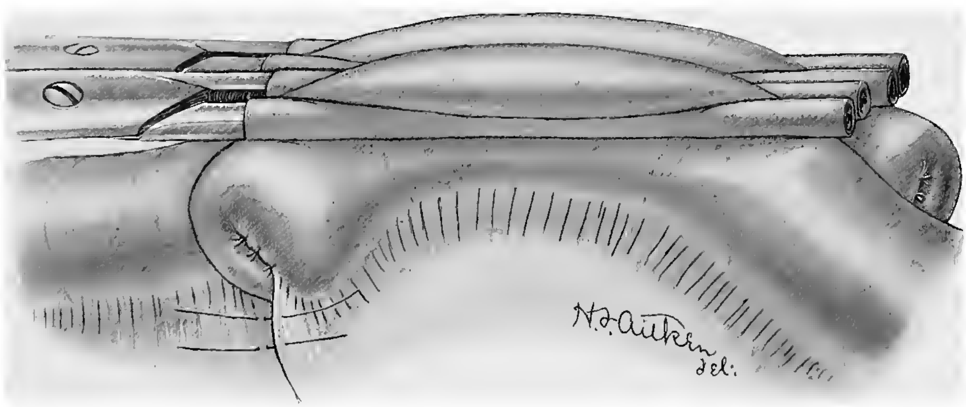


FIG. 114.—LATERAL INTESTINAL ANASTOMOSIS.

Note the position of the clamps in relation to the closed ends. Also note the method of attaching the cut mesenteric edges. The remaining technic for the lateral anastomosis will be shown under gastroenterostomy.

tinuous stitch. A margin of one-fourth inch is to be kept laterally, between this stitch and the bowel incision. During the operation, the bleeding from the cut edges is prevented by the clamps, and, to control this upon their removal and strengthen the suture, the cut edges are sewed together with a continuous No. o chromic stitch. The details of placing the inner through-and-through stitch are to be found under the technic of posterior gastroenterostomy. The conclusion of the stitch is accomplished by invaginating the continuous chromic stitch with an outer layer of seromuscular stitches, which is continued over the front by the long end left from the first outside stitch.

THE MATTRESS SUTURE.

In performing lateral anastomosis by means of Connell's mattress method the technic described for the end-to-end anastomosis is followed as closely as possible.

Steps:

(1) Clamps.

(2) Intestine opened on either side at once.

(3) Three mattress stitches to incision angle.

(4) Interrupted mattress stitches to circumference.

The clamps should be first applied in the long axis of the bowels, in the manner adopted for the plain suture. When the clamps are placed in this way it is much easier to open the intestine, as the folds are held in exactly the proper position. The intestinal incisions are made as usual, with long sweeps of the knife down to the mucosa, when scissors are substituted for the knife to cut away the redundant mucous membrane. The removal of the redundant mucous membrane is fully illustrated under the technic of Finney's gastroduodenostomy. In beginning the suture three mattress stitches are placed at one angle of the wound, the upper of the three being left long to mark the point of ending after the whole circumference has been closed in. Interrupted stitches are next placed across the base line from one incision angle to the other, thus joining the cut edges. When the second angle is reached the stitch is left long to be used as a guide in sewing the second portion of the circumference. Up to this time guides have not been required because the clamps have held the edges in apposition. The eversion of the anterior cut edges is more difficult in lateral than in end-to-end anastomosis, and cannot be accomplished without changing the clamps. The intestinal openings are carefully filled with gauze, and the contents stripped back with the fingers for a distance of three or four inches, at which point the clamp is reapplied at a right angle to the axis of the gut. When no obstruction is present, in either of the attached coils, four clamps will be needed to prevent leakage from the bowel lumen, one above, and one below the opening into each intestine. To approach the second portion of the circumference a mattress guide is introduced into the anterior cut edges at a point half way between the incision angles, in

a manner exactly similar to that described for the end-to-end union. The gauze is removed from the bowel lumina and the long ends of the stitch left at the second incision angle are passed under the anterior guide and are gently drawn tight. The mucous membrane is thus turned inside out and held by drawing the two guides steadily apart. In everting this second portion of the circumference great care must be exercised to avoid tearing the stitches out of the tissues, because the counter pull of the clamps and of the attached intestines is often difficult to overcome. The completion of the anastomosis is a repetition of the end-to-end technic. The everted portion of the circumference is sewed together and replaced, after which the gap remaining is brought together by interrupted mattress stitches which are apparently reserved. The last stitch is placed from the outside. The continuous mattress stitch has been favored by M. E. Connell[1] for lateral union, but, although more rapid, it is less safe than the interrupted method on account of the danger of slipping.

MECHANICAL DEVICES.

(a) Jaboulay's button; ring; bobbin.

(b) McGraw rubber ligature.

Jaboulay's Button.[2]—This mechanical device, which is constructed in a general way upon the principle of the Murphy button, has been used with apparently good results, for some years, in the clinic of Jaboulay in Lyons. The reference given is Jaboulay's most recent description of the button. The experimental work done by Beer[3] with the Jaboulay button does not support the claims made by the inventor of the instrument. Beer describes the mechanism of the button as follows: "Each half is made up of two cylinders, an outer and an inner. The outer is perforated with drainage holes, just as in the Murphy button, though the openings are of different contour. At one point in the outer cylinder there is a distinct break in the continuity of this cylinder; this gap or slit is prolonged into the inner cylinder, and continues almost half way around the inner cylinder. It measures, in a 22-millimeter size button, approximately one-

[1] Connell, M. E. Medical Record, 1892, Vol. XLII, p. 335; Journal Am. Med. Asso., 1893, Vol. XXI, p. 150; North Am. Practitioner, September, 1898.

[2] Jaboulay. Medizinsche Klinik, March 12, 1905.

[3] Beer, E. Annals of Surgery, November, 1905.

eight of the diameter of the button. It is vertical in the outer cylinder, running through its entire thickness; whereas, in the inner cylinder, it is at first vertical, corresponding to the slit in the outer cylinder, but very shortly bends at right angles, and runs, as said before, almost half-way around the inner cylinder. In this slit the Jaboulay idea is concentrated. By means of this slit the button can be introduced into the lumen of the bowel through a small opening. Naturally the same slit arrangement is present in the male and female halves of the button, and these fasten into each other by means of a screw thread arrangement, somewhat similar to the mechanism of the Murphy button. As the outer cylinder has been interrupted by the slit which runs through it, to obtain approximation of the two pieces of bowel at this point when the buttons are driven home, Jaboulay had to prolong the mesial margins of the outer cylinder,—*i. e.*, the margins which come in contact with each other when the buttons are approximated, otherwise there would be leakage at this point. The prolongation of this margin is in the form of a thin, elongated metal plate, which acts like a weak spring in closing the slit in the upper or mesial border of the cylinder. The extra cylinder of the Murphy button, which works on a spring and whose function is to force and hold the two apposed serosa surfaces against each other, and eventually produce their necrosis, is not used in the Jaboulay button. In this button the apposition and subsequent necrosis are produced by the operator's forcing the two halves of the button very firmly together."

Steps:

(1) Clamps.
(2) Bowel incisions one centimeter long.
(3) Introduction of button halves.
(4) Joint snapped together.

The presence of a longitudinal groove through the flanges of the button halves allows them to be put in sidewise. The halves are held separately with artery forceps, as is usual with the Murphy button, and the edge of the intestinal cut slipped into the slit in the side of the flange. By rotating the button, it will screw itself into the intestinal lumen through an opening which has a diameter much smaller than the largest part of the button. Jaboulay steadies the cut edges of the opening with forceps, while twisting

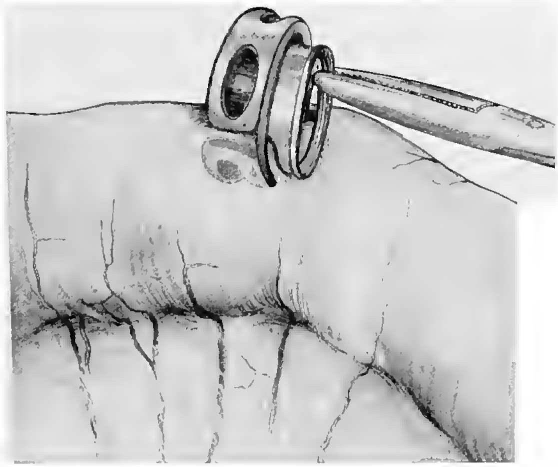


Fig. 115.—Lateral Anastomosis with Jaboulay's Button.

One-half of button being turned into intestinal opening, the portion of the flange already within the lumen showing faintly through.

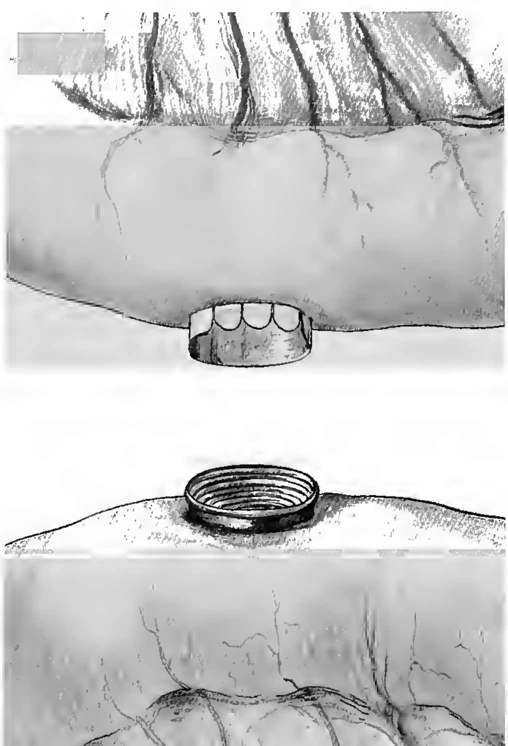


Fig. 116.—Lateral Anastomosis with Jaboulay's Button.

Both halves of the button are in place, ready to be snapped together. Note absence of purse-strings.

the button into position. The two halves are finally snapped together forcibly and the joint thus completed (Figs. 115, 116). Beer did not find, experimentally, that a button 22 millimeters in diameter could be screwed into an opening one centimeter long without tearing the bowel. He reports that eighteen tears in the serosa resulted from introducing twenty-eight button halves, all of which required sutures to close the rents. In no instance, however, did the mucosa prolapse through these rips, as it does through the larger incisions used for the Murphy button technic. Beer saw no bad results from the tearing or stretching of the opening, but regards the contrivance as inferior to the Murphy button.

In summarizing his experiments, Beer states that the Jaboulay button actually offers an increase in speed over the Murphy button, but two minutes being required for the technic. The small intestinal incision, though of advantage in doing away with sutures, results in tears of the bowel wall. Finally, the halves must be driven home with great force in order to insure necrosis of the included tissues, although, even then, the button frequently becomes so fixed in the joint that it is not passed. The Jaboulay button has been little used in this country, and the results of experimental work are discouraging. The technic is described here without advice as to its adoption.

The Harrington Ring.—This technic differs in no particular from the end-to-end method, with the single exception of the omission of the mesenteric stitch. The placing of the purse-string for lateral anastomosis is shown in Fig. 58. Harrington puts in the first half of the seromuscular stitch before opening the bowel.

Steps:

(1) Purse-string.

(2) First half of seromuscular stitch.

(3) Bowels opened, ring introduced.

(4) Second half of seromuscular stitch.

With this method the exposure of the field of operation to infection from the opened intestine is reduced to its minimum time. The purse-strings are placed at the desired points, with both arms of the loop parallel and about one-fourth inch apart. The bowels are next attached with a seromuscular stitch which projects a short distance over each end of the purse-

strings. The incisions are then made and the ring slipped into the lumina, where it is fastened in place by tying the purse-strings. The seromuscular stitch is finally carried around the remainder of the circumference, and the joint thus completed. The removal of the handle is done at the last moment, just before the last stitch is taken, and the hole left is covered by the outer continuous stitch.

The Robson Bone Bobbin.—This device has been previously described. In lateral anastomosis the use of the button is merely a slight elaboration over the customary method of suture in two layers.

Steps:

(1) Clamps.
(2) First half of seromuscular stitch.
(3) Incisions.
(4) Inner through-and-through stitch.
(5) Bobbin introduced.
(6) Second half of seromuscular stitch.

The placing of the clamps in the long axis of the viscus, the seromuscular continuous stitch, the incisions, the inner through-and-through continuous stitch, are all done in the routine manner. Before closing in the front of the joint, with the inner through-and-through stitch, a bone bobbin of the proper size is introduced, and the inner stitch closed over it. The outer continuous seromuscular stitch is taken up again and used to bury the portions of the inner stitch which are still uncovered.

The McGraw Rubber Ligature.—The use of the rubber ligature for the lateral anastomosis of hollow viscera has become identified with the name of McGraw. Although the actual originator of the method was J. M. Gaston,[1] it was the practical technic of McGraw which brought the method into favor. Since McGraw's first article appeared[2] there have been various minor improvements suggested, all of which were summarized by F. T. Murphy[3] in a paper which contains several useful original details. The technic described below is, substantially, that recommended by McGraw and by Murphy. The ligature is made in three sizes: large, 5 mm.;

[1] Gaston, J. M. Atlanta Med. and Surg. Journal, 1884–5, Vol. I, pp. 336, 385; *Ibid.*, 1885–6, Vol. II, pp. 395, 533.

[2] McGraw. Journal Am. Med. Asso., 1891, Vol. XVI, p. 685.

[3] Murphy, F. T. Boston Med. and Surg. Journal, January 28, 1904.

medium, 4 mm.; small, 3 mm. The largest size is very much stronger than the others, and cuts out rapidly, but the medium size (4 mm.) is preferable on account of its elasticity. Ochsner prefers the smallest size. The needle which McLean[1] has devised to hold the ligature has rendered the technic simpler (Fig. 117). This needle is made in several sizes. In place of an eye a hook is substituted at one end, over which the ligature is stretched and caught. The rubber is prevented from slipping off by a movable ferrule which is forced down over the ligature as it is held by the hook, thus tightly joining the end of the ligature to the needle. The size of the ligature must be carefully chosen so that the ferrule cannot work

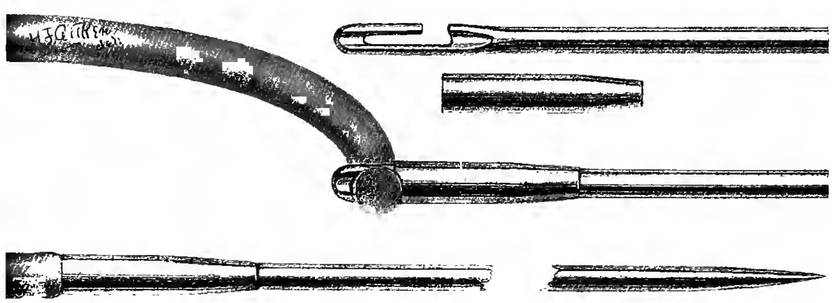


FIG. 117.—McLEAN NEEDLE FOR THE RUBBER LIGATURE.
Enlarged in diameter. Method of attaching the ligature to the needle.

loose. One case has been reported where the ferrule slipped down over the rubber with unfortunate results.[2]

The limitations in the use of the McGraw ligature are not well defined. It has been used with success in cholecystenterostomy, gastroenterostomy, and in lateral intestinal anastomoses, and is a rapid and safe method, even in patients of poor vitality. There has been a prevailing opinion that it is a dangerous technic to employ in bad subjects, or in tissues of poor vitality. The Mayos[3] and Ochsner,[4] however, have had excellent results with the elastic ligature in gastroenterostomy. W. J. Mayo states that the ligature will cut through in patients with poor resistance, if the tissues

[1] McLean. Journal Mich. Med. Soc., Detroit, 1903, II, 550.
[2] McGraw. Journal of the Michigan State Med. Society, August, 1904.
[3] Mayo, W. J. Annals of Surgery, November, 1905.
[4] Ochsner. Journal of the American Medical Asso., October 21, 1905.

have even a small vitality, but that when the intestinal or the gastric walls have lost the power to produce an inflammatory reaction, the ligature will not cause a slough of the tissues within its grasp. One of the great recommendations of the rubber ligature is the short time required for its introduction; Mayo finds that twelve minutes are sufficient for a gastroenterostomy, while McGraw[1] has performed this operation in three minutes. In comparing this with other methods of gastroenterostomy, in cases of patients with poor resistance, Mayo expresses a feeling that there is more danger of uncircumscribed slough or infection when the Murphy button or the suture in layers is used than when the ligature technic is adopted.

The two objections commonly advanced against the use of the elastic ligature are the following: (1) In the process of freeing itself by pressure-necrosis of the included tissues, from three to five days are demanded, during which period the advantages attributed to the immediate drainage following suture and certain mechanical operations are lost. McGraw argues, however, that patients are not able to avail themselves of the new channel until after a lapse of from two to three days, on account of gastric irritability and refusal of the stomach or intestine to contract, in the presence of an injury to its walls. The experience of Dr. McGraw is not wholly corroborated by that of other operators who have been successful in feeding patients on the day following the operation, where the anastomosis was made with sutures. (2) The second objection raised has to do with inaccurate technic. In a certain number of cases, as pointed out by McGraw himself,[2] the needle may not enter the lumen of the bowel but may turn before freeing itself of the mucosa, an error which is alluded to later in the technical description. When such a condition exists, a portion of the mucous membrane will not be grasped by the rubber band. As a result, when the ligature has contracted as far as possible, it will be held in place by a bridge of uncrushed tissue, which will prevent the subsequent discharge of the ligature. This is a fault in technic which is easily avoided by plunging the point of the needle well into the cavity of the organ before gathering the fold on the needle.

Although this method of anastomosis has not been accepted as adapt-

[1] McGraw. New York Med. Journal, January 26, 1901.
[2] McGraw. Journal Am. Med. Asso., May 16, 1891.

able to all lateral anastomoses, it has a recognized place in gastrointestinal surgery. The method should not be employed to make a pyloroplasty or a cholecystenterostomy.[1]

Steps:

(1) Clamps omitted.

(2) Preliminary continuous seromuscular stitch.

(3) Rubber ligature knotted in middle and threaded at both ends.

(4) Needle introduced into lumen, picking up longitudinal fold of bowel $2\frac{1}{2}$ to 3 inches long.

(5) Ligature put on stretch and pulled through to knot in middle; same process repeated in second coil.

(6) Two ends tied in square knot and held with silk while first line of sutures is depressed with forceps.

(7) Front and ends buried with interrupted stitches.

Clamps are not necessary because the only openings made in the bowels are plugged by the ligature. The two coils are first fastened in place with a seromuscular stitch, to steady the suture in a manner exactly similar to that adopted for the plain lateral anastomosis. Murphy found that the cutting out of the ligature advanced more rapidly under the knot, and, for this reason, advises that a second knot be placed at the other extremity of the suture. This is done by tying a half-knot in the middle of the ligature after which both ends are threaded. The point of one of the needles is introduced into the lumen of the bowel at a right angle to the axis of the gut. The operator must make certain that the point is free of the mucous membrane before turning, else the ligature cannot completely cut out the fold. The needle is now turned and pushed up the lumen until it has gathered a longitudinal fold of bowel about three inches long, when the point escapes from the bowel as nearly as possible at a right angle with the wall. The needle is grasped with artery forceps while the ligature is held by the knot in the left hand. By separating the hands the rubber is put on the stretch and is pulled through to the knot, an assistant wiping away with a moist sponge the intestinal contents which are brought out on the needle and the ligature. After repeating this manœuvre on the second coil, the ends are ready to be knotted (Fig. 118).

[1] Ochsner. Journal of the American Medical Asso., October 21, 1905.

To prevent including the preliminary continuous stitch in the knot, this suture is depressed with forceps, and the ends of the rubber ligature tied in a half-knot over a piece of strong silk (Fig. 119). While the operator

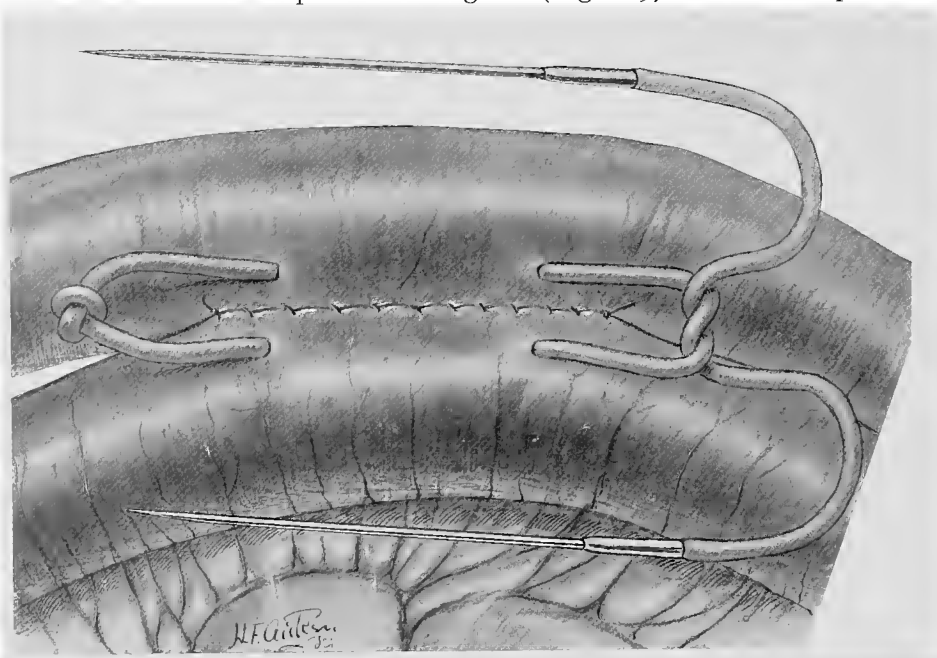


FIG. 118.—LATERAL ANASTOMOSIS BY THE MCGRAW LIGATURE.

The first seromuscular stitch has been placed. The rubber ligature has been introduced with two needles. Note knot on left (Murphy) in middle of rubber ligature to increase the speed of the cut-out.

holds the ligature ends tight, the silk is tied over the front in a square knot, thus securing the rubber from slipping. The second half of the knot is completed in the same manner as the first half. After tying the rubber ligature it will be noticed that the longitudinal folds which it grasps are puckered into a number of wrinkles. This puckering will, later, flatten out when the ligature cuts through, if the front and ends are buried in with interrupted stitches (Fig. 120). It is probable that a continuous stitch does not allow complete relaxation of the wrinkles when it is used to bury in the front, and may thus partly constrict the opening. The complete cutting through of the ligature requires from four to five days. It is necessary to tie the rubber as tightly as possible, because, if loosely done, the rubber will stop cutting before it has freed itself, and leave two holes instead of one free opening (Figs. 121, 122).

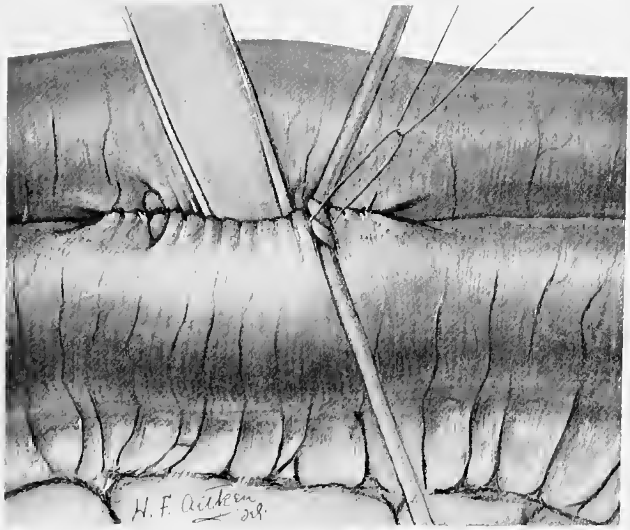


FIG. 119.—LATERAL ANASTOMOSIS BY THE McGRAW LIGATURE.

The ligature is being drawn taut, thus dragging the two knots together. Note method of depressing the first seromuscular suture with the blunt end of forceps. Note position of silk tie which is to secure the knot in the rubber ligature from slipping.

FIG. 120.—LATERAL ANASTOMOSIS BY THE McGRAW LIGATURE.

This shows the three stages of the technic. On the right the first seromuscular continuous stitch is visible, while, to its left, the intestine is puckered up by the rubber ligature, which has been tied tight and cut close. On the extreme left are seen the interrupted seromuscular stitches with which the whole front of the joint will be closed in.

END-TO-SIDE INTESTINAL ANASTOMOSIS.

(AUTHOR'S METHOD.)[1]

After resection of the ileocecal valve, and certain other operations, the

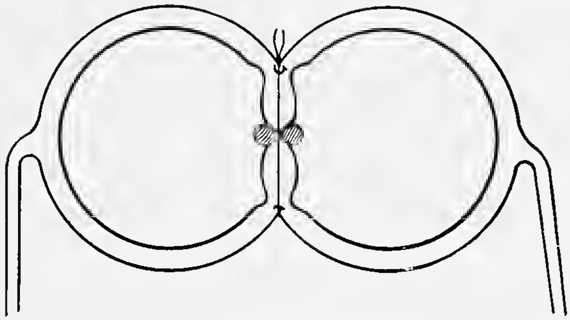


FIG. 121.—LATERAL ANASTOMOSIS.
A cross section of the anastomosis, McGraw ligature.

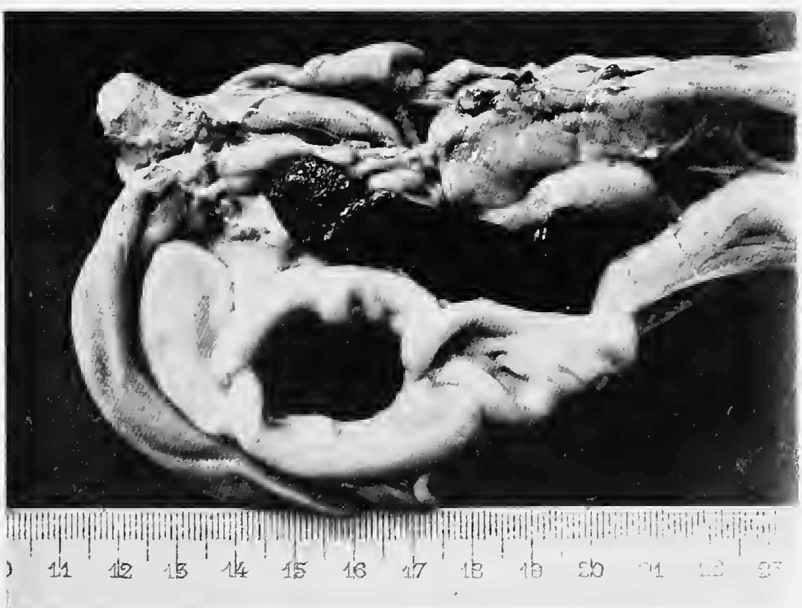


FIG. 122.—LATERAL ANASTOMOSIS BY THE MCGRAW LIGATURE.
From a photograph to show the actual opening made by means of the elastic ligature between the stomach and jejunum. Specimen taken from cat. (Murphy.)

ileum is anastomosed to the large intestine. A lateral anastomosis is very effective (Abbe);[2] but it requires the closure of two blind ends. The end-

[1] Gould, A. H. Boston Med. and Surg. Journal, December 29, 1904.
[2] Abbe. Medical Record, 1892, Vol. XLI, p. 365.

FIG. 123.—END-TO-SIDE ANASTOMOSIS (AUTHOR).

Shows the method of application of the first mattress stitch. The dotted line on the small intestine indicates the line at which corners will be cut off. The small dots on the edges of large and small bowels show the points where the first two guides are placed.

FIG. 124.—END-TO-SIDE ANASTOMOSIS (AUTHOR).

The first mattress stitch has been tied and the first two guides pulled tight. The mesenteric third of the circumference of the small intestine has been approximated to a symmetrical portion of the distal edges of the cut into the colon, by an over-and-over stitch. The third guide has been loosely introduced to show the correct position.

FIG. 125.—END-TO-SIDE ANASTOMOSIS (AUTHOR).

The suture is nearly completed, the seromuscular layers being approximated by a new mattress stitch. Old mattress A brought to A. New mattress B brought to A.

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to-side operation implants the cut end of the small intestine into the side of the colon. The following technic was worked out on animals:

Steps:

(1) Clamps.
(2) Ileum resected obliquely.
(3) Incision into colon.
(4) Mesenteric border of ileum fastened into distal angle of cut in colon, by a mattress stitch.
(5) Guides develop mesenteric border.
(6) Through-and-through stitch of all coats.
(7) Interrupted seromuscular stitch, either reversed mattress, or Lembert.
(8) Cut mesenteric edge attached to colon, or adjoining structure.

The application of the clamps is not shown in the drawings. The small intestine should be clamped at a right angle, about three inches above the cut end, while the clamps on the large intestine are also placed at a right angle, a short distance to either side of the incision. The open small intestine to be implanted is first split along its free border, for one-half inch to an inch (Fig. 123), and the corners which project are trimmed down with scissors, so that an oblique opening is left, with edges rounded out near the mesenteric border. The reason for rounding the edges at the mesenteric border, instead of cutting them straight, is that it allows more tissue for sewing at this point. The receiving intestine is opened on its free edge for about one and one-half inches, and the distal end of this cut fastened by a mattress stitch to the mesenteric border of the entering bowel.

Fig. 123.

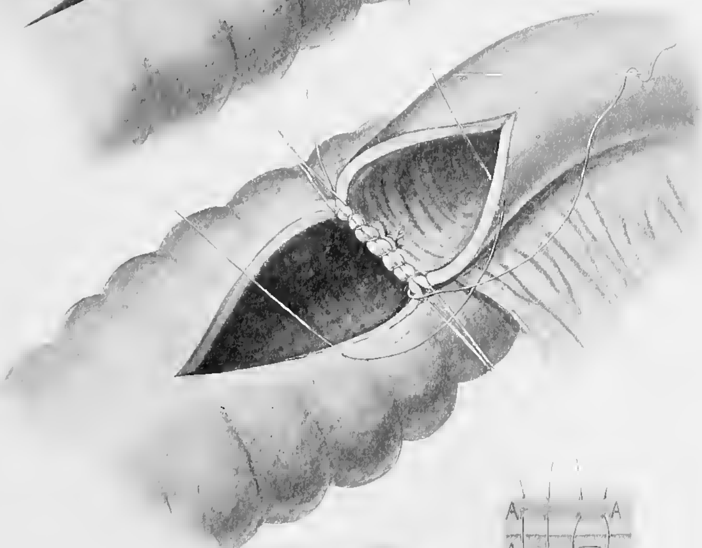

Fig. 124.

Fig. 125.

Guides are placed, with the ends inside, to invert the cut edges and expose the mesenteric third of the entering bowel, side by side with a symmetrical portion of the cut edges of the receiving bowel (Fig. 124). The remainder of the suture is finished exactly as in the plain end-to-end anastomosis. The author's mattress or the interrupted Lembert stitches are both useful for the seromuscular layer (Figs. 125 and 126). The cut edge of the mesentery of the small intestine is finally attached by interrupted stitches to the colon and the posterior abdominal wall, if possible, to avoid hernia of the intestines beneath the arch. The degree of obliquity at which the small bowel is attached to the large is not fixed. The adaptation of the

FIG. 126.—END-TO-SIDE ANASTOMOSIS.
Cross section.

mattress mesenteric stitch to this technic requires that a wider edge be turned in at the distal angle of the wound, where this stitch is attached, than necessary for the rest of the circumference, just as has been noted in the plain end-to-end anastomosis. To counteract the pull made by this stitch, the entering bowel must be cut slightly on the oblique, and this will leave the two intestines fastened at right angle when the suture is completed. The old method of attaching the end to the side by the technic of lateral anastomosis occasionally leads to stricture formation, and, on this account, it is safer to give the entering bowel a more oblique attachment than would be absolutely necessary to overcome the pull of the mesenteric

stitch, thus forming an opening which has a larger caliber than that of the entering bowel.

If the steps of this operation are followed carefully, a joint will be obtained which will be as strong and as safe as the plain end-to-end or the lateral anastomoses; while on the other hand, the danger from sepsis and prolonged time-requirement will be minimized.

COLOSTOMY.

By colostomy is meant the establishment of an artificial opening into some part of the colon. This opening may be either permanent or temporary, and the technic is modified according to the permanency of the opening desired. There are two methods of approaching the colon for purposes of drainage,—extra- or intraperitoneal. The extraperitoneal route is called *lumbar colostomy*, an operation which was formerly regarded with great favor on account of its avoidance of the peritoneal cavity, but which has now fallen into disuse. It is said to be indicated in cases where the sigmoid flexure has a short mesentery, or is otherwise bound down to the posterior abdominal wall. According to Treves,[1] a mesocolon may be expected on the left side in thirty-six per cent. of all cases, and on the right side in twenty-six per cent. In view of these facts it is evident that it would not be possible to open the colon, extraperitoneally, in a large number of cases. Improvements in aseptic technic have removed the chief indications for the lumbar route, allowing the bowel to be approached directly through the peritoneal cavity. Lumbar colostomy has, for the above reasons, been omitted from the list of operations to be described.

In the great majority of cases, colostomy for disease of the lower sigmoid or rectum, or both, is done in the left inguinal region; but, in case of involvement of the colon higher up, the transverse colon may be opened in the median line, or, if necessary, the ascending colon in the right inguinal region, always above the diseased section of bowel.[2] The location of the incision for inguinal colostomy is not regarded at present to be of great importance, provided that it is made below the level of the umbilicus, between the outer edge of the rectus muscle and a point at least one inch

[1] Treves, F. Applied Anatomy, 1892, p. 346.
[2] Gant, S. G. American Medicine, June 24, 1905.

internal to the anterior superior spine of the left ilium. The operations to be described are the following:

Permanent Colostomy.

(1) Left inguinal.

(2) Anterior.

Temporary Colostomy.

(1) Rubber ligature.

(2) Glass drainage tube.

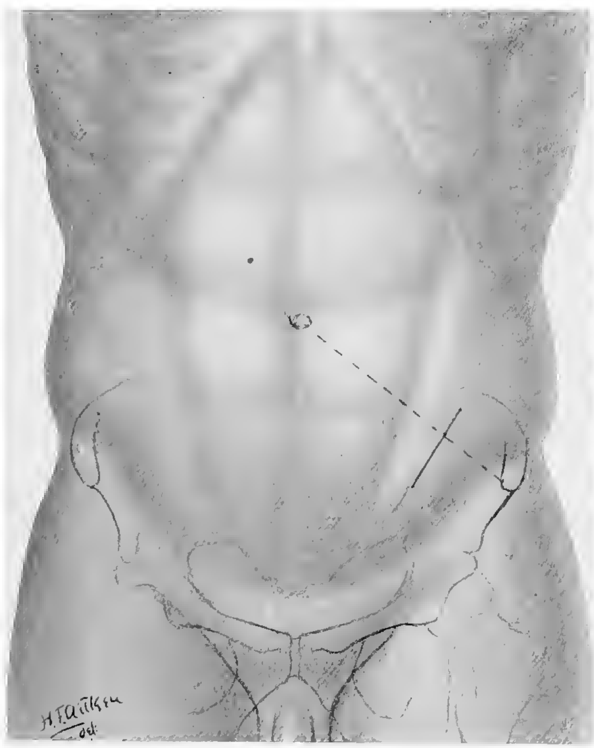

FIG. 127.—LEFT INGUINAL COLOSTOMY.
Line of incision.

LEFT INGUINAL COLOSTOMY.

(ALLINGHAM, MAYDL, GANT.)

Gant[1] accepts Allingham's[2] technic as the most reliable. He combines it with Maydl's[3] muscle-splitting operation, as follows:

[1] Gant, S. G. Diseases of the Rectum and Anus.
[2] Allingham. Brit. Med. Journal, 1892, I, p. 1013.
[3] Maydl. Cent. für Chir., 1888, No. 24.

Steps:

(1) Incision, muscle-layers separated.
(2) Sigmoid withdrawn from the abdomen.
(3) Mesosigmoid drawn taut and made fast with stitch.
(4) Circumference of bowel attached to skin.
(5) Dressing, resection after adhesions have formed.

The skin incision is made nearly at right angles to an imaginary line, drawn between the navel and the anterior superior spine of the left ilium

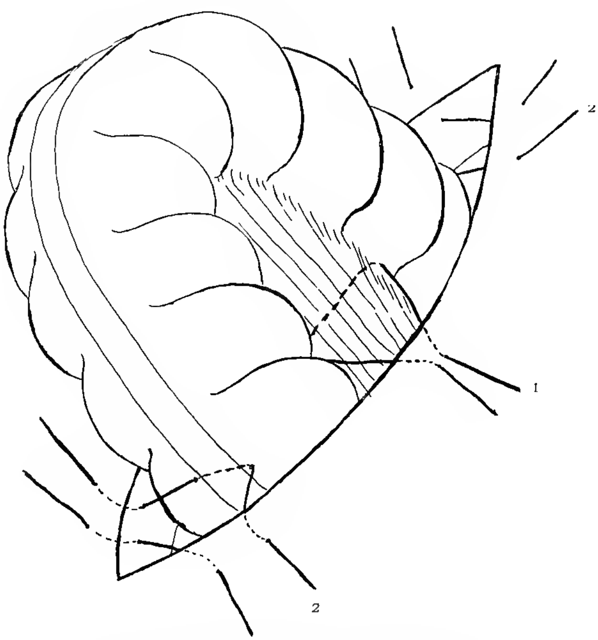

FIG. 128.—LEFT INGUINAL COLOSTOMY.
Method of placing stitches. 1. Mesenteric stitch; 2, Anchor stitch at either angle of wound.

(Fig. 127). This cut is about two and one-half inches long and is placed two inches to the inner side of the iliac spine, one-third of the incision being above, and two-thirds below the line just mentioned. The three muscle-layers are separated in the lines of cleavage of their fibers (Maydl) and the abdomen entered through an opening of about one and one-half inches.

The sigmoid is next located, and the length of its mesentery determined at once. Occasionally, the mesentery is very short, or absent, when it is not possible to bring the bowel far enough forward to employ this technic with success. The loop is pulled upward until the afferent and the efferent

arms are taut (Allingham), in order to forestall the possibility of prolapse. To form the spur, and prevent the intestine from slipping back into the abdomen, an insoluble or a chromic-gut stitch is introduced, as follows: While the loop is still taut, the needle is thrust through the skin in the middle of and about half an inch from the edge of the lower lip of the wound.

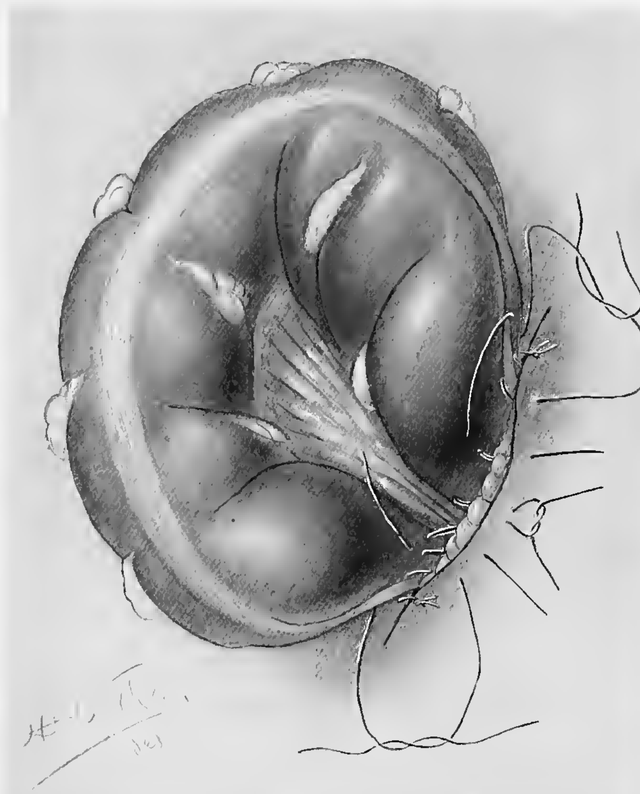

FIG. 129.—LEFT INGUINAL COLOSTOMY.
Coils drawn together by mesenteric stitch. Interrupted stitches attaching bowel to skin.

After penetrating the skin, the needle picks up a bite of the afferent arm of the loop under the mesenteric attachment. The stitch then crosses behind the mesentery, and is passed through the mesenteric attachment of the efferent loop, whence it penetrates the skin again, and is tied to the first end (Fig. 128). In tying the stitch just described, the two arms of the loop are drawn together, thus forming an efficient spur. The skin incision is next closed in, at either end, with interrupted stitches, until it fits the

bowel snugly on all sides, after which a row of interrupted catgut stitches fastens the bowel to the skin. At either angle of the incision the catgut stitch penetrates beneath the longitudinal band (Fig. 129). If sufficient obstruction is present to demand relief, a glass tube is attached to the coil in the manner shown in the next operation. The bowel is otherwise left without drainage until adhesions have hermetically sealed in the abdominal cavity. The resection is done four or five days later; Gant insists upon leaving from one-fourth to one-half inch free edge of bowel above the skin level, as accidents occasionally result from retraction of the bowel into the abdomen. The bleeding from the cut bowel-edges is best controlled by a running catgut stitch, around the circumference, through all coats (Fig. 130).

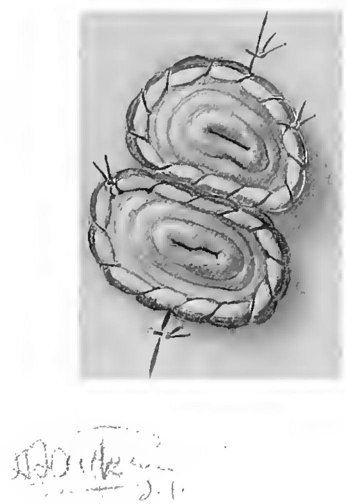

Fig. 130.—Left Inguinal Colostomy.
Afferent and efferent coils amputated $\frac{1}{4}$ to $\frac{1}{2}$ inch above level of skin. Continuous catgut stitch about circumference of bowel.

In cases where the sigmoid lies unopened on the surface of the abdomen for several days while awaiting resection, great care must be taken to avoid compression of the coil, else the circulation of the intestinal contents will be impeded. The peritoneal surface is coated with vaselin or with zinc oxid powder, and this covered with gutta-percha tissue, to anticipate and prevent adhesion to the dressing. A wall of dressing is built up on all sides of the bowel, in such a manner that obstruction cannot result.

ANTERIOR COLOSTOMY.

(Mixter.[1])

The principle of using the rectus muscle as a sphincter to assist in the control of the motions has been brought out in the writings of Weir,[2] von

[1] Mixter, S. J. Unpublished Technic.
[2] Weir. Journal Amer. Med. Asso., xxxv, p. 1458.

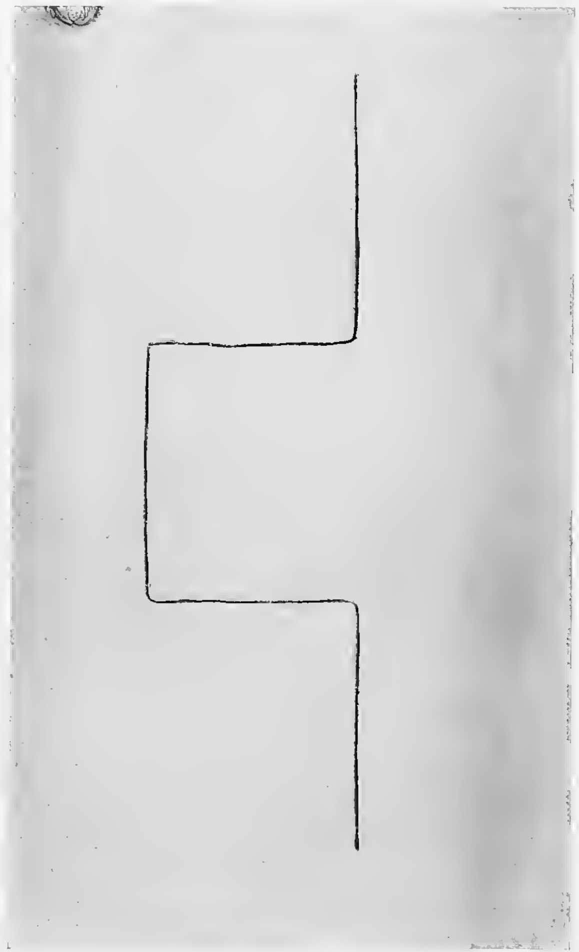

FIG. 131.—MIXTER'S ANTERIOR COLOSTOMY.
Line of incision.

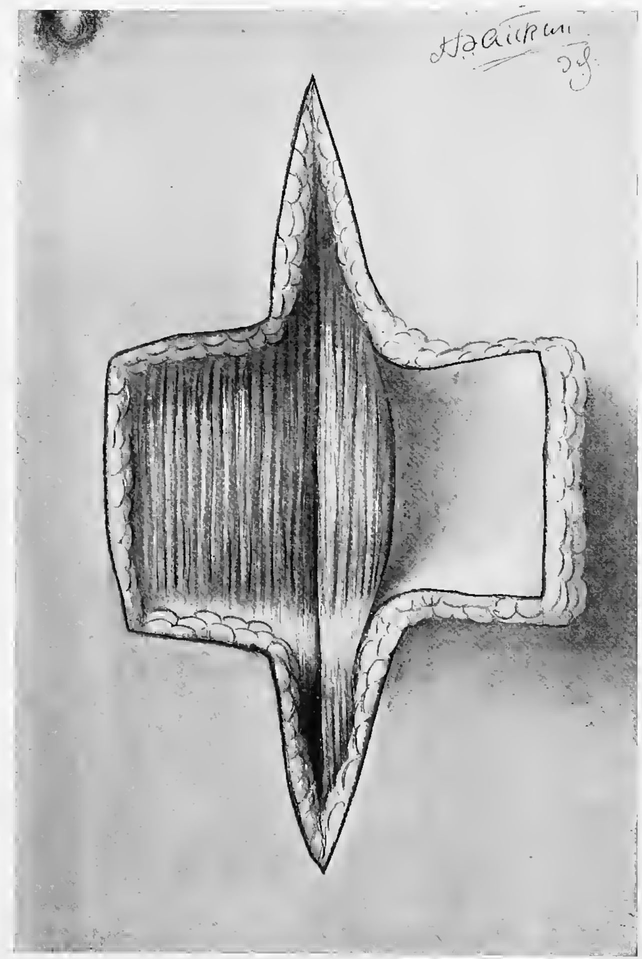

FIG. 132.—ANTERIOR COLOSTOMY.
Flap of skin, and subcutaneous tissue, including fascia of rectus.

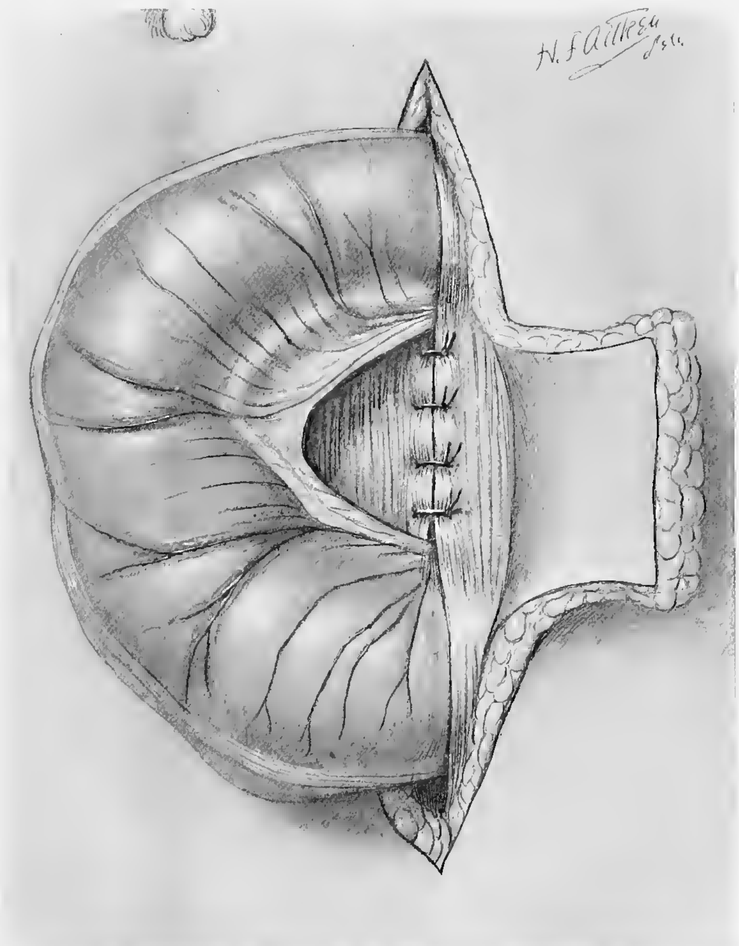

FIG. 133.—ANTERIOR COLOSTOMY.

Sigmoid withdrawn, mesentery pulled taut and incised. Rectus muscle sewed together between afferent and efferent coils.

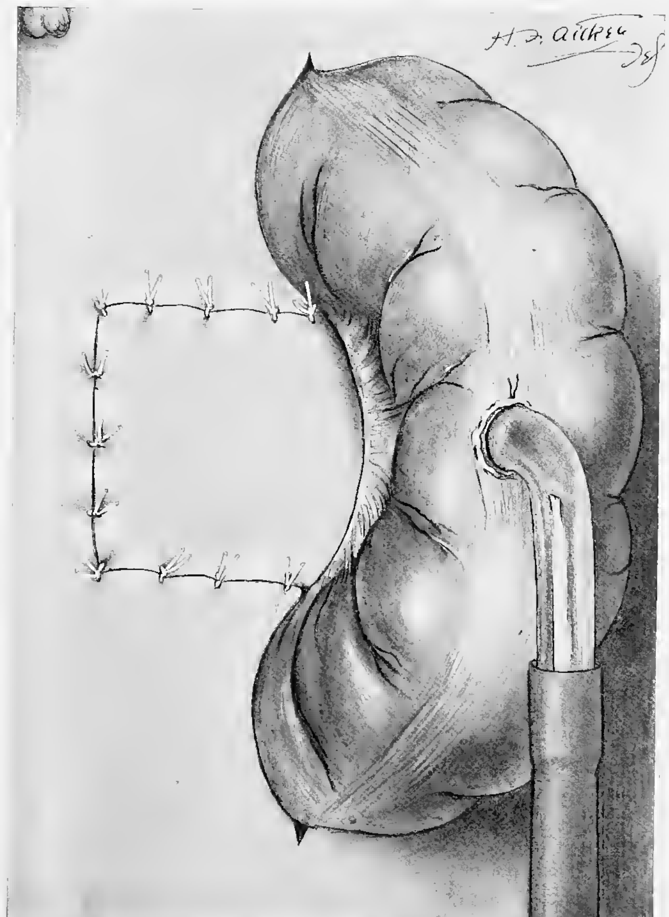

FIG. 134.—ANTERIOR COLOSTOMY.

Flap fastened into original position under arch of sigmoid, with two layers of sutures. Mixter tube in place.

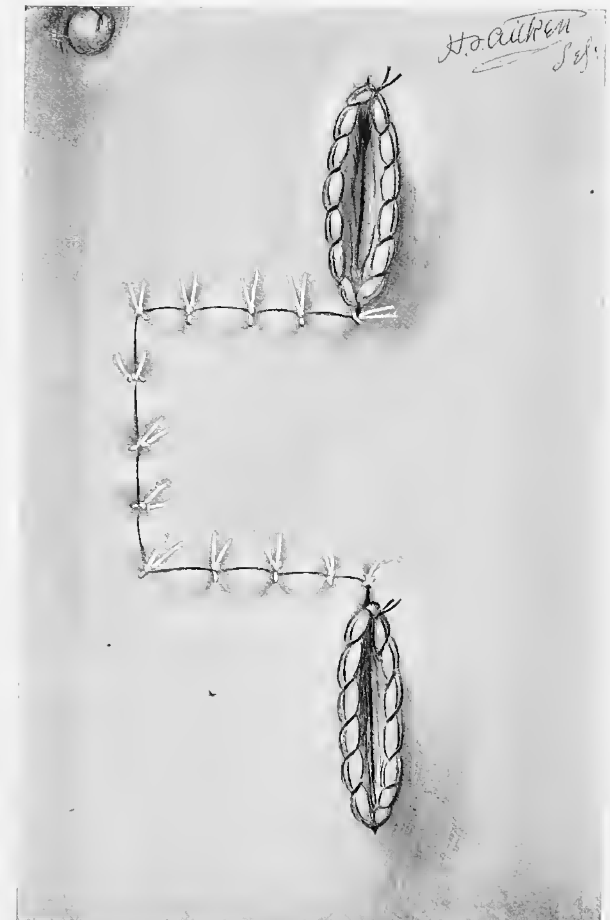

FIG. 135.—ANTERIOR COLOSTOMY.

Sigmoid resected $\frac{1}{4}$ to $\frac{1}{2}$ inch above skin level. Circumference of cut edges sewed with catgut.

Hacker,[1] and others. The operation, presently to be described, is really an adaptation of Audry's[2] method of left inguinal colostomy, although it was devised several years ago by Dr. Mixter, without knowledge of Audry's work.

Steps:

(1) Right-angle incision through skin and rectus fascia.
(2) Lid of skin and fascia reflected outwards.
(3) Separation of fibers of rectus muscle.
(4) Peritoneum opened, loop of sigmoid withdrawn.
(5) Mesosigmoid split at right angle to long axis of bowel.
(6) Rectus muscle sewed together between afferent and efferent arms of bowel loop.
(7) Skin flap pulled through opening in mesosigmoid and sewed into original position.
(8) Glass drainage-tube fastened into coil, if obstruction is present.
(9) Resection of loop, after four days.

As shown in Fig. 131, the incision commences at the level of the navel and passes downward for about two inches, cutting skin, subcutaneous tissue,

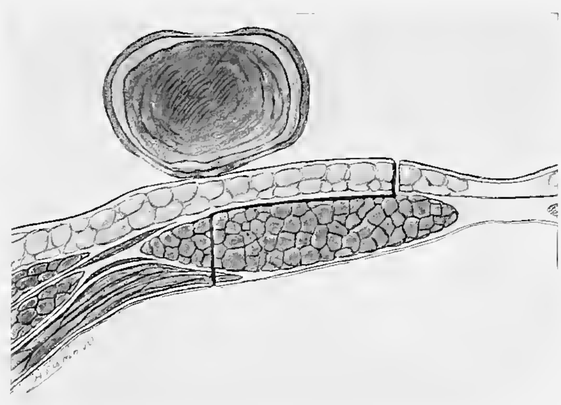

FIG. 136.—CROSS SECTION OF ANTERIOR COLOSTOMY (HORIZONTAL).
Section of sigmoid. Left rectus abdominis, at junction with oblique and transversalis muscles. Flap of skin and fascia.

superficial and rectus fasciæ. The line of this part of the cut is parallel to the fibers of the rectus muscle, a short distance inside of its outer border.

[1] Von Hacker. Beiträge zur Klin. Chir., XXIII, 1899, p. 628.
[2] Audry. Archives prov. de Chir., 1892, Vol. I, p. 347.

At this point the knife turns inward, at a right angle, then downward, and again outward, to form three sides of a square, the length of each of which will be approximately two inches. The cut finally turns downward at a right angle for two inches, as if in continuation of the first leg of the incision, parallel with the fibers of the rectus. The lid of skin, subcutaneous tissue, superficial and anterior rectus fasciæ is dissected away from the belly of the rectus muscle, and reflected outward (Fig. 132), after which the muscle fibers are separated longitudinally by blunt dissection near the outer border of the muscle, and the peritoneum opened. The sigmoid is withdrawn from the abdomen, and drawn taut as in the previous operation. The mesosigmoid is split at a right angle to the long axis of the bowel for a distance of about two inches, and the cut edges of the incision held apart, while the middle portion of the separated rectus muscle is sewed together with through-and-through catgut sutures (Fig. 133). The coil of sigmoid now arches across the approximated portion of the rectus muscle, and under this arch the lid of skin and fascia is drawn, to be fastened firmly into its original position with two layers of interrupted stitches, one for fascia, the other for skin. If acute obstruction is present, drainage is established by inserting a right-angled Mixter[1] glass tube of large caliber, held in place with a purse-string stitch (Fig. 134). The bowel is finally dusted with zinc oxid powder, and covered with gutta-percha tissue to prevent the peritoneum from adhering to the dressing. After four or five days the dressing is removed, and the coil of sigmoid resected with scissors from a quarter to a half-inch above the skin, on either side, trimming the mucous membrane flush with retracted muscular coats. Bleeding from the cut edges of the bowel circumference is controlled by a continuous suture of catgut, as in the inguinal colostomy (Fig. 135). The proximal and the distal openings are now wide apart, and a satisfactory sphincter is formed by the rectus muscle. The separation of the bowel openings prevents feces from gaining access into the distal coil. The distal opening is used for washing out the contents which accumulate if the rectum is obstructed. Fig. 136 shows a cross section of the operation before the resection has been done.

[1] Mixter, S. J. Boston Med. and Surg. Jour., 1895, Vol. CXXXII, p. 206.

COLOSTOMY WITH THE RUBBER LIGATURE.

(McGraw.[2])

McGraw advises the following technic for resection of tumors of the large intestine:

Steps:

(1) Exploratory abdominal incision.

(2) Withdrawal of coil involved in growth, new abdominal incision, if necessary.

(3) Rubber ligature anastomosis, between afferent and efferent coils of loop.

(4) Resection of growth; efferent coil closed; temporary drainage of afferent loop, with a glass tube.

(5) Afferent opening shut up, after four or five days, when ligature has cut out; abdomen closed.

The abdominal incision is made directly over the growth, when the latter can be located; otherwise, in the median line. If the incision has been purely exploratory, a second opening is added, immediately over the tumor, and the exploratory opening closed. The coil of large intestine involved in the growth is drawn out through the abdominal opening, and its mesentery palpated for glands. A lateral anastomosis is first performed, with a rubber ligature between the two arms of the loop, proximal and distal to, and about three inches distant from, the tumor (Fig. 137). The ligatured portion is slipped back into the abdomen, and the growth clamped off, preliminary to a resection. Purse-strings are placed around the circumference of the bowel on either side of the area to be resected, and the field of operation walled off with gauze. In resecting the bowel, the side distal to the growth is first completed, the open end of the efferent gut being turned in by Mayo's method. The stump, thus formed, is now tucked back into the belly, and the abdominal incision closed over it, up to the point of exit of the afferent coil. The proximal side of the diseased area is, finally, cut away, with its V of mesentery, leaving a safe margin, and the glass tube, slipped into the afferent coil, is fastened in place by tying the purse-string suture, already introduced. The clamp, which has held back the intestinal contents, is

[2] McGraw. Annals of Surgery, November, 1904.

taken off, and drainage is established through the tube (Fig. 138). A few interrupted stitches attach the afferent coil to the skin, at its point of emergence. After four of five days the cutting out of the rubber ligature will be signalled by the resumption of rectal movements. When this occurs, the afferent loop is closed in, and replaced within the abdomen, and the abdominal wall sewed up over it. Fig. 139 shows the position of the anastomosis with relation to the line of the abdominal incision. Caution must be exercised in piercing the distended afferent loop with the rubber ligature that the bowel wall be not torn.

TEMPORARY COLOSTOMY WITH GLASS TUBE.

This method is adopted to sidetrack the fecal current. It is of value as a preliminary step to any suture of the large intestine. Gant advises its use in the presence of many lesions of the lower bowel.

Steps:

(1) Bowel fastened to surface, as in permanent colostomy.

(2) Insertion of glass tube, incision parallel to long axis of intestine.

The early steps of the operation consist in fastening the gut to the surface of the skin. This operation, though temporary in nature, is only relatively so, since the colostomy is frequently kept open several months for purposes of treatment. The colon is fastened to the surface by the usual method, preferably by the Allingham-Maydl-Gant technic. The glass tube is fastened into the bowel by means of a purse-string, the incision being made parallel to the long axis of the gut. Fig. 134 shows the method of inserting the glass tube.

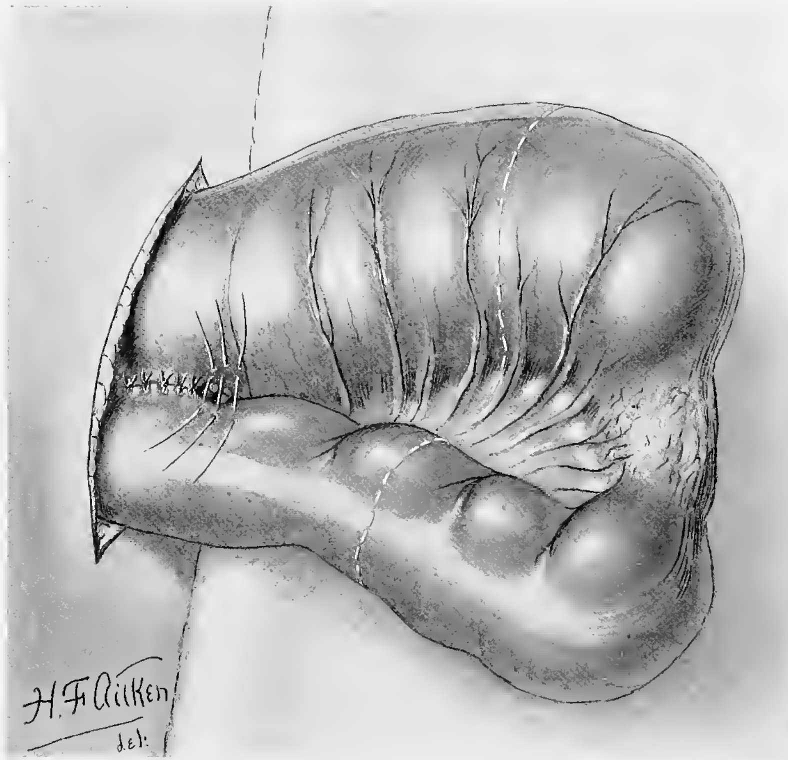

Fig. 137.—McGraw's Colostomy with Resection.

Rubber ligature placed between afferent and efferent arms of loop. Dotted line marks portion to be cut out.

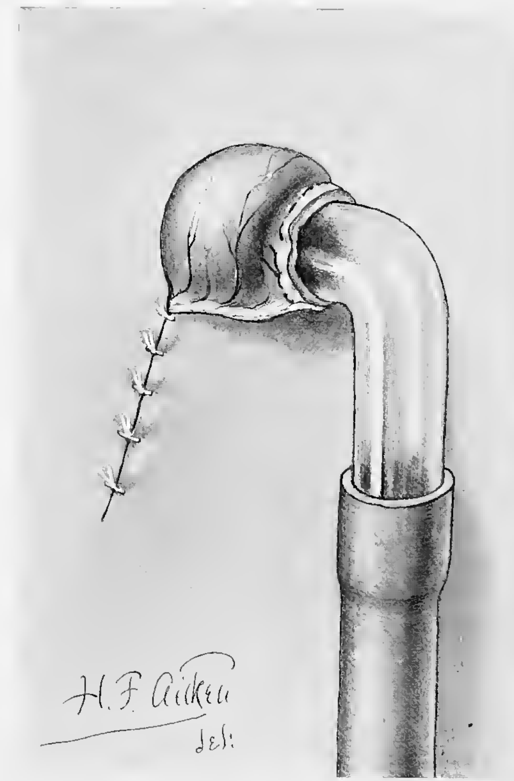

Fig. 138.—McGraw's Colostomy with Resection.

Resection completed. Efferent stump closed, and replaced within abdomen. Abdominal wound closed up to exit of afferent coil. Mixter tube in afferent coil.

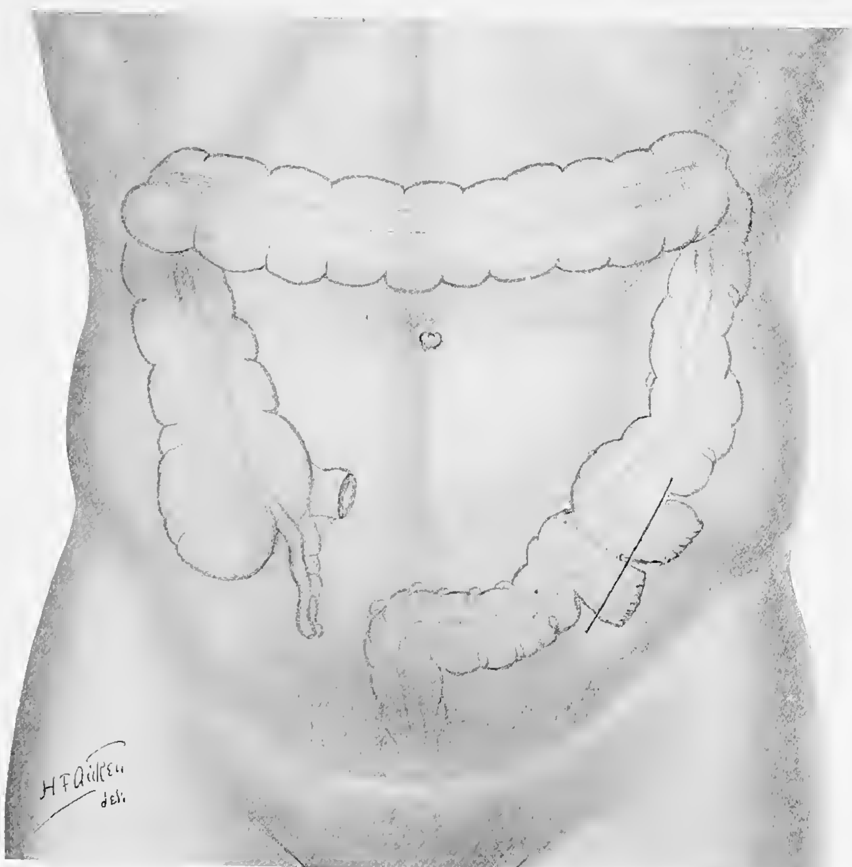

Fig. 139.—McGraw's Colostomy with Resection.
Line of original incision. Large intestine visible through the abdominal wall. Lateral anastomosis with ligature seen under incision.

CHAPTER V.

OPERATIONS UPON THE STOMACH.

GASTROTOMY.—GASTROSTOMY: WITZEL, SSBANAJEW-FRANCK.—PYLORODIOSIS: HAHN, LORETA.—PYLOROPLASTY: HEINECKE-MIKULICZ.—GASTRODUODENOSTOMY: FINNEY, KOCHER.—GASTROENTEROSTOMY: POSTERIOR, ANTERIOR.—PYLORECTOMY.—PARTIAL GASTRECTOMY.—EXCISION OF ULCER.—GASTROPLASTY.—GASTROGASTROSTOMY.—GASTROPLICATION.

GASTROTOMY.

Robson and Moynihan[1] give the following indications for exploration of the stomach:

1. For the removal of foreign bodies from the stomach.
2. For the removal of foreign bodies from the lower end of the esophagus.
3. For dilating a stricture of the esophagus.
4. For dilating a stricture of the pylorus.
5. For the removal of a polypus, or other tumor, projecting into the stomach.
6. For exploration in case of intractable or bleeding ulcer.
7. For curetting cancer of the pylorus in Bernay's operation.

Steps:

(1) Examination of anterior wall.
(2) Examination of glandular groups.
(3) Examination of posterior wall.
(4) Walling off.
(5) Anterior wall opened parallel to vessels, or over foreign body.
(6) Treatment of interior, closure of stomach.

Exploration of the stomach may be done: to remove a foreign body from the stomach, or from the esophagus; to dilate a stricture of the stomach or of the esophagus; for treatment of special lesions, such as bleeding gastric ulcer. There is a difference of opinion about the value of lavage, preliminary to exploration of the stomach, although most writers agree that it is desirable to evacuate its contents as far as possible before operating.

[1] Robson and Moynihan. "The Surgical Treatment of Diseases of the Stomach," Second Edition, p. 32.

The abdomen is entered through a free incision, and the stomach brought forward. The anterior wall is first examined, by inspection and by palpation, to locate any indurated areas. If pyloric stenosis is suspected, the caliber of the sphincter is gauged with the finger, a portion of the anterior wall being invaginated for this purpose. A thorough investigation of the glandular groups is next carried out, since ulcer, or malignant disease, send their metastases to pathognomonic groups. Lund[1] has pointed out the value of "sentinel glands" to indicate the site of ulcers of the stomach. A discussion of the lymphatic drainage of the stomach is included in the technic of pylorectomy. If the anterior wall and the pylorus are free from disease, the stomach is lifted forward, and its posterior wall inspected. Adhesions of the mesocolon to the stomach may give a clue to disease on the posterior wall.

The exploration of the interior of the stomach is done through an incision on the anterior wall. When foreign bodies or tumors are plainly palpable, the opening is made directly over them; otherwise, the incision is placed in the center of the stomach parallel to the vessels. Before making the opening the stomach is pulled out and carefully walled off from the abdomen with gauze. It is possible to bring in review the whole of the posterior wall by inserting the hand through the gastrocolic omentum (Fig. 140), and pushing forward the posterior wall with the fingers. When the mesocolon is adherent to the posterior wall, this manœuvre must be done without entering the lesser peritoneal cavity. After accomplishing the object desired, the stomach is closed with two layers of sutures.

GASTROSTOMY.

This operation consists in the establishment of a more or less permanent artificial gastric fistula, which has its outer opening in the abdominal wall. It is employed for the purpose of feeding, or for treatment in cases of obstruction of the esophagus and of the cardiac end of the stomach.

Owing to the number of operations in use, some difficulty is encountered in choosing the best technic. Berndt[2] states that, in establishing a gastric

[1] Lund, F. B. Boston Medical and Surgical Journal, 1902, Vol. CXLVI, p. 469.

[2] Berndt. Arch. f. Klin. Chir., Berlin, 1905, LXXVI, 905–916.

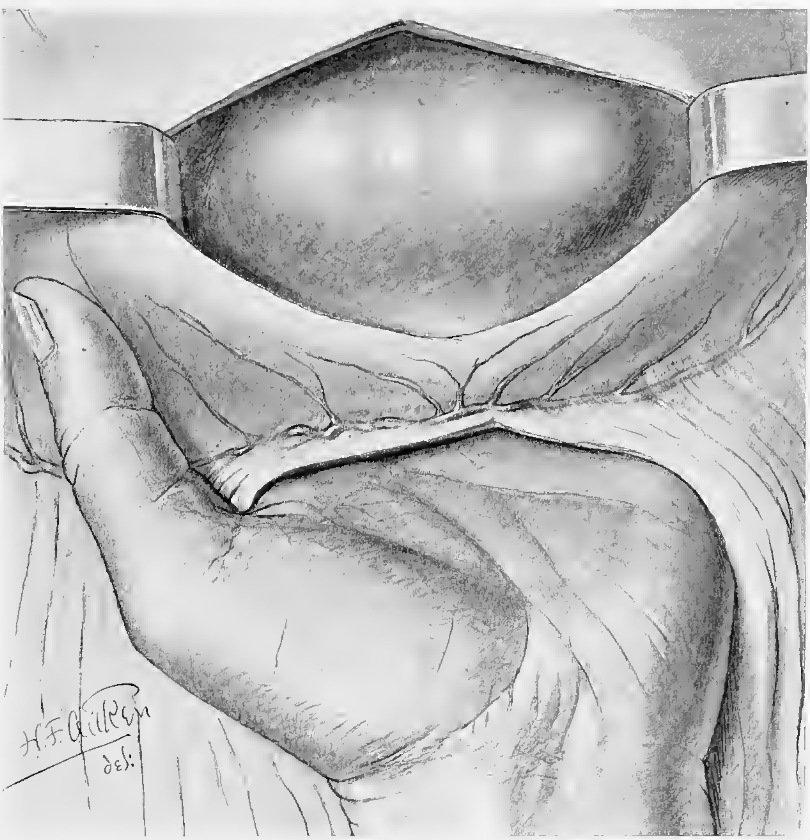

FIG. 140.—GASTROTOMY (modified from Cheyne and Burghard).

The anterior wall of the stomach is held apart by retractors. The posterior wall is pressed forward by the fingers in the lesser peritoneal cavity.

fistula, the technic should be adopted which allows a subsequent complete and spontaneous closure of the fistula, after it has served its purpose. The spontaneous closure of the fistula is rarely desired in the large class of cases of malignant obstruction for which this operation is usually demanded, so that this factor is of less importance than at first appears. Berndt divides the operations for gastrostomy into three classes: 1. Those in which a sphincter is formed in the abdominal wall itself (Hacker,[1] Girard,[2] Ullmann,[3] and others); 2. Those in which a portion of the gastric wall is drawn out in a cone (Hahn,[4] Ssbanajew,[5] Franck[6]); 3. Those in which a canal is made in or through the anterior gastric wall (Witzel,[7] Fischer,[8] Marwedel,[9] Kader[10]). In reviewing the reported cases Berndt found that the sphincter made from the abdominal musculature alone had given few favorable results. The cases done by von Hacker's original method were obliged to use special apparatus, such as a rubber balloon, to protect the skin from the digestion and irritation which results from the leakage of the gastric juice over the abdominal wall. It is a procedure which has not held its place beside more practical methods.

The originator of the cone operation was Hahn, who made an incision immediately below the left costal border. He perforated the eighth intercostal space, from below upward, through which hole he drew the stomach, using the elastic costal cartilages as a stop-cock. Although this method is effectual, it is said that the fistula gradually becomes enlarged, and occasionally leads to necrosis of the costal cartilages, which accounts for its limited use. Ssbanajew, Franck, and Albert have modified Hahn's technic so that a cone of the stomach is brought through the rectus muscle and fastened under a bridge of skin by means of a second incision over the costal cartilages. Berndt is positive that this operation, by its inherent peculiarities, does away with the possibility of a spontaneous

[1] Von Hacker. Wien. Klin. Wochenschr., 1890, III, 348.
[2] Girard. Korrespondenzblatt für Schweizer Aertze, 1888.
[3] Ullmann. Wien. Med. Wochenschr., 1894, XLIV, 1662–1664.
[4] Hahn. Centralbl. für Chir., Leipzig, 1890, XVII, 193–195.
[5] Ssbanajew. Centralbl. für Chir., 1893, No. 40.
[6] Franck. Wien. Med. Wochenschr., 1893, S. 231.
[7] Witzel. Centralbl. für Chir., 1891, S. 601.
[8] Fischer. Deutsch. Chirurgenkongress, 1895.
[9] Marwedel. Beiträge, z. Klin. Chir., 1896, Bd. 17, S. 56.
[10] Kader. Centralbl. für Chir., 1896, S. 665.

closure. In all forms of cone and canal operations subsequent observations show that the two openings of the gastric fistula tend to approach each other. This apparently does not interfere with the continence of the valve, if the rectus muscle is used as a sphincter. In Witzel's canal-forming operation a catheter is sewed into the stomach, and the latter attached to the abdominal wall. This has proved to be a good method, but it has a limited application in cases where the stomach is too contracted to furnish the proper gastric surface into which to bury the catheter. This objection also holds against the cone operation.

The Witzel and the Ssbanajew-Franck technics are described in this book because it is felt that they are the most popular operations. In conditions where the stomach is too small to allow these operations to be used the technic devised by Marwedel or by Kader may be employed, in which but a small portion of the gastric wall is required.

WITZEL'S GASTROSTOMY.

Steps:

(1) Incision; exploration of stomach.

(2) Stomach withdrawn from abdomen, and catheter buried in anterior wall, the eye pointing to the left.

(3) Point of catheter inserted into stomach, for two inches, and opening buried.

(4) Line of suture buried, with a second layer of seromuscular stitches.

(5) Stomach anchored to abdominal wall by two interrupted stitches.

(6) Closure of abdominal wall; wicks.

The abdomen is entered through the fibers of the left rectus muscle, between the ensiform cartilage and the umbilicus. The opening should be large enough to allow easy exploration of the stomach, the point to determine being whether or not the stomach is contracted to such a degree as to make the operation impossible. If the stomach is large enough for the purpose, it is withdrawn from the abdomen, and its anterior wall drawn downwards. A large catheter, or a rectal tube, is buried in the anterior wall with seromuscular stitches, for a distance of three inches, parallel to the lesser curvature, with the eye of the catheter pointing upward and to the left as high

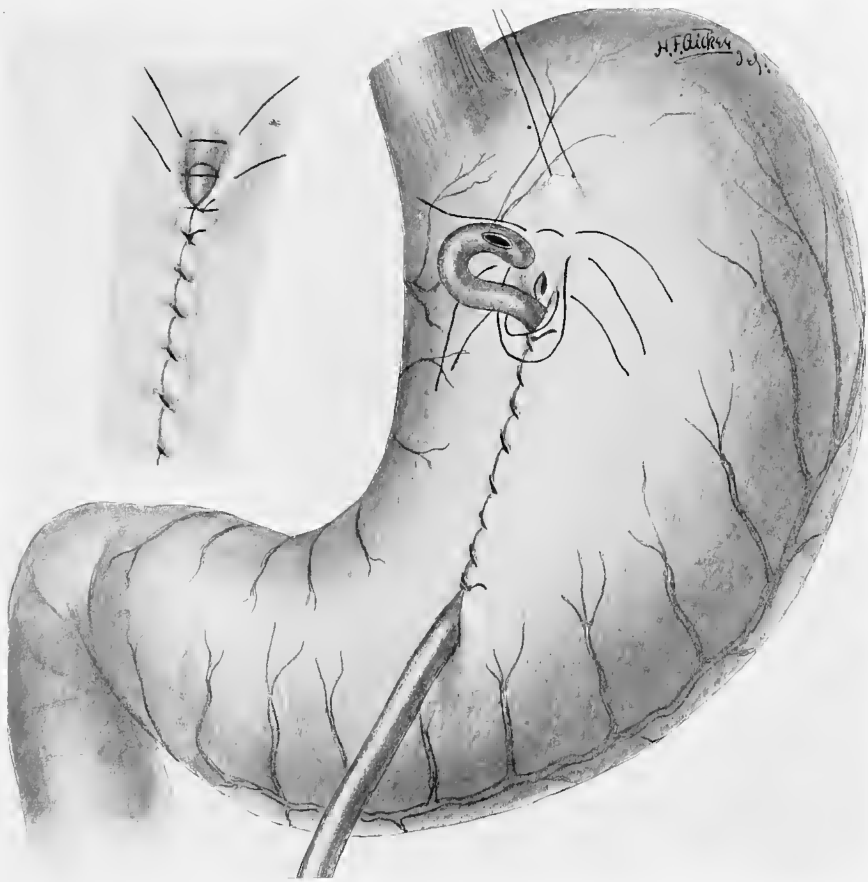

FIG. 141.—WITZEL'S GASTROSTOMY.

Catheter partly buried in stomach. Guide stitch above opening. Interrupted stitches placed before inserting point of catheter.

Fig. 142.—The eye of the catheter has been inserted within the stomach. Interrupted stitches ready to tie.

as possible. The higher the eye is placed, the less likely is regurgitation to take place. Before opening the stomach, a guide stitch is introduced, just above where the opening is to be made, in order to steady the stomach as it is being incised. Two interrupted stitches are next introduced, but not tied, over the point where the opening is to be made. A quick thrust of the knife opens the stomach, and the redundant edges of mucous membrane are trimmed away with scissors (Fig. 141). The catheter is now slipped into the stomach for

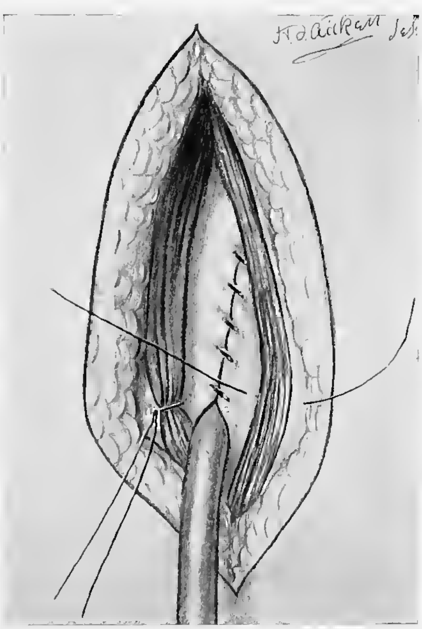

FIG. 143.—WITZEL'S GASTROSTOMY.

Stomach fastened to anterior abdominal wall by interrupted stitches. These stitches penetrate all layers, including the anterior rectus fascia. The ends are left long to assist in removal, later.

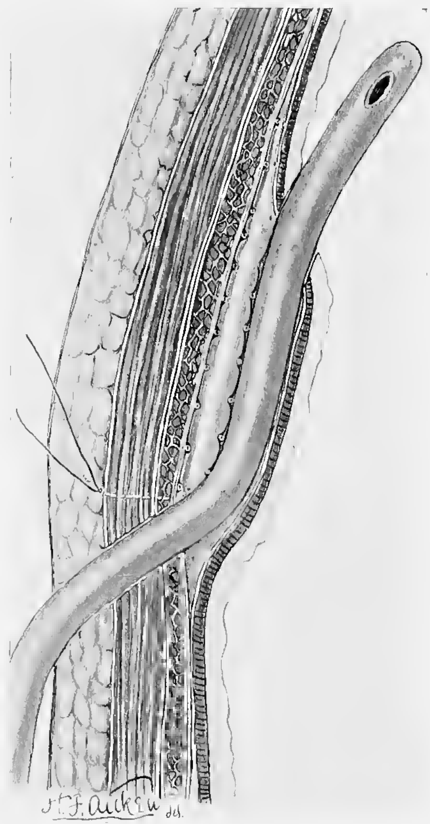

FIG. 144.—WITZEL'S GASTROSTOMY, CROSS SECTION.

Eye of catheter is in the cavity of the stomach. Note the various layers through which the catheter passes.

about two inches, and its hole of entrance buried by tying the interrupted stitches already placed (Fig. 142). It is safer to close in the line of suture with a second layer of seromuscular stitches, placed from above downward. As soon as the eye of the catheter enters the stomach, the outer end of the catheter is clamped to prevent leakage.

The stomach is finally anchored to the abdominal wall. Mixter accomplishes this by means of two interrupted stitches which pick up the stomach on each side of the lower exit of the catheter. One arm of the stitch penetrates all the abdominal layers, through, and including, the anterior fascia of the rectus muscle, and is tied to the other arm as it lies across the cut edges of the abdominal wound (Fig. 143). The abdomen is closed, in layers, or with through-and-through stitches, as preferred. Small spaces are left above and below the exit of the catheter for purposes of drainage, which is done with cigarette wicks. The ends of the stitches which anchor the stomach are left long, outside of the abdominal wound, and are used to assist, later, in the removal of the stitches themselves, after the stomach has become firmly fixed to the abdominal wall by adhesions. Feeding may commence at once, if necessary; the wicks are removed on the second day. Fig. 144 is a cross section.

The catheter is kept in place as long as artificial feeding is necessary, since the fistula will tend to close on the withdrawal of the tube, thus rendering its subsequent introduction difficult. It is customary to remove the catheter while carrying out Abbe's treatment for esophageal stricture (cutting stricture with string).

THE SSBANAJEW-FRANCK GASTROSTOMY.

This technic has been repeatedly modified by various surgeons. The method described here is the one most commonly accepted.

Steps:

(1) First incision, parallel to ribs, rectus split.
(2) Second incision, above costal margin, parallel to first.
(3) Bridge of skin, between two cuts, raised by blunt dissection.
(4) Cone of stomach wall pulled out, and passed under bridge.
(5) Closure of skin over first incision.
(6) Apex of cone opened after two days.

The first skin incision is about three inches long, and is made, according to Fenger, in a line parallel to, and about one and one-half inches from the left costal border, commencing near the middle line (Fig. 145). The fibers of the rectus muscle are separated, vertically, and the peritoneum opened. A second incision, three-fourths inch long, is next made parallel to the first,

through skin and fascia, about one inch above the costal margin. A portion of the anterior wall of the stomach is taken up, near the cardiac end, and drawn out through the abdominal incision in the form of a cone (Fig. 146). This cone is prevented from slipping back by four stitches which attach its base to the cut peritoneal edges of the abdominal wound. The bridge of skin intervening between the two incisions is raised by blunt dissection just enough to allow the cone to be passed beneath and fastened (Fig. 147), after which the skin is completely closed over the first incision

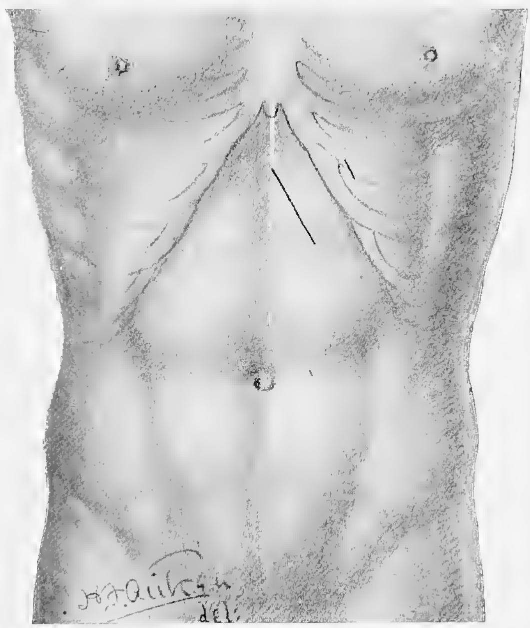

FIG. 145.—SSBANAJEW-FRANCK GASTROSTOMY.
Incision lines.

(Fig. 148). The opening of the cone is deferred for two or three days; but it may be done at once, if necessary. Fig. 149 is a cross section.

PYLORODIOSIS.

This operation consists in enlarging the pyloric outlet of the stomach by stretching. It was formerly much used for benign and, occasionally, for malignant strictures of the pylorus.

There are two objections to the technic, the first being the transient nature of the results obtained. Although immediate relief may be ex-

perienced after stretching of the pylorus, the reported cases frequently show a return of the symptoms within a few months or weeks. The second objection to this operation is the danger of rupturing the duodenum. Several cases of fatal peritonitis have been attributed to this cause.[1] In recent years stretching of the pylorus has been superseded by more effective operations, although, in occasional cases of spasm[2], [3], or hypertrophy of the circular fibers of the pylorus[4], [5], [6], [7], the results yielded are said to have been good.

There are two methods of stretching the pylorus, known from their originators as the operations of Loreta and of Hahn.

LORETA'S OPERATION.[8]

In his first operations Loreta opened the stomach about three centimeters from the sphincter, parallel with and about half way between the curvatures. He then pushed a finger slowly and gradually into the contracted outlet. This process was continued until it was possible to introduce both index fingers, one of which was used to steady the pylorus, while the other was gradually separated from the first. In this manner a very large opening was effected. Manual dilatation afterwards gave way to the use of instruments, so that in the rare instances where Loreta's operation is now employed the stretching is done with bougies, sounds, or a uterine dilator. It is recognized, nevertheless, that the use of instruments for the purpose of stretching the pyloric sphincter adds a considerable risk to the operation from the increased danger of tearing the duodenum.

Steps:

(1) Incision into the stomach.

(2) Dilatation of the pylorus.

The gastric incision is best made at right angles to the long axis of the pylorus, at least two inches proximal to the sphincter. This method minimizes the hemorrhage since the cut is practically parallel to the vessels. Beside

[1] Swain. London Lancet, 1891, I, 87.
[2] Carle and Fantino. Arch. f. Klin. Chir., Bd. LVI, Heft 1.
[3] Boas. Arch. f. Verdauungskr., 1898, Vol. IV, p. 47.
[4] Thayer. Johns Hopkins Hospital Bulletin, 1893, Vol. IV, No. 31.
[5] Hirsch. Berl. Klin. Wochenschr., November 9, 1896.
[6] Lindstrom. Hygeia, September, 1899, p. 267.
[7] Kammerer. Annals of Surgery, 1900, Vol. XXXII, p. 18.
[8] Loreta. Mem. Accad. d. Sc.d. Ist. di Bologna, 1882, 4, S, IV, 353-375.

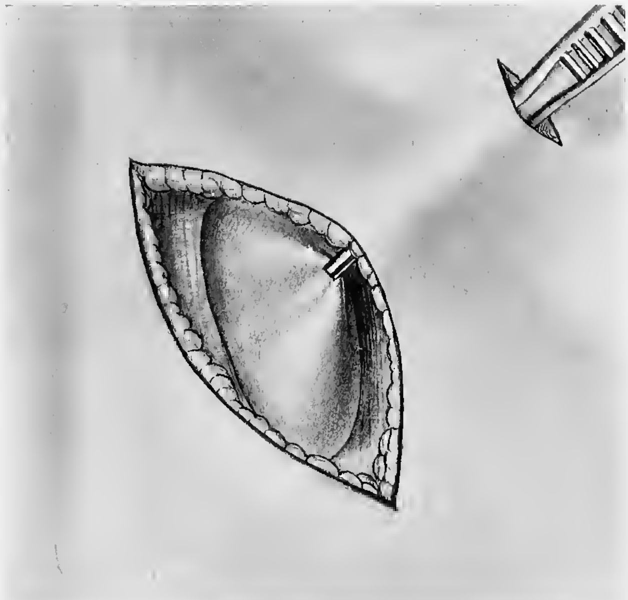

Fig. 146.—Ssbanajew-Franck Gastrostomy.
Bridge of skin dissected up. The cone of the stomach is being pulled beneath bridge.

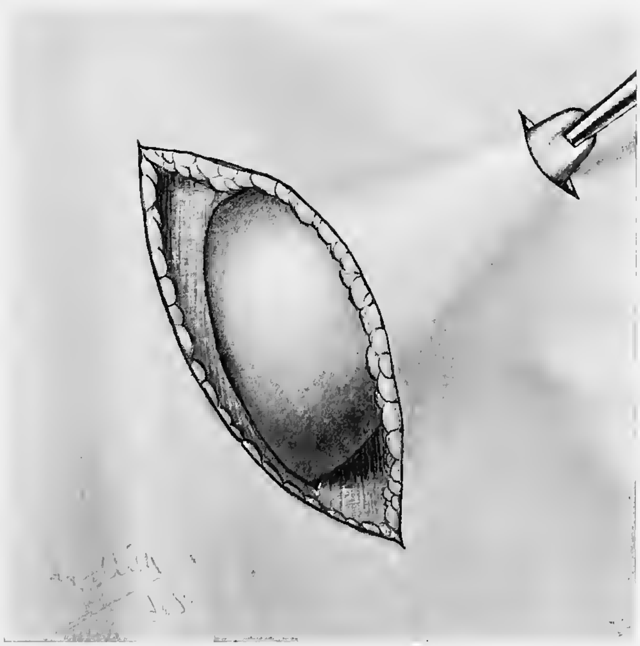

Fig. 147.—Ssbanajew-Franck Gastrostomy.
Cone of stomach held in place with forceps. The base of the cone fastened to the peritoneum with interrupted stitches. These stitches are only visible in the cross section.

Fig. 148.—Ssbanajew-Franck Gastrostomy.
Skin closed over base of cone. Apex of cone opened and sewed to skin.

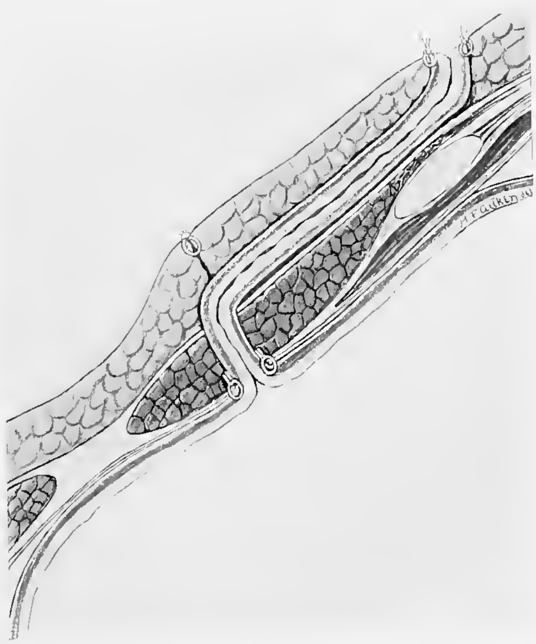

Fig. 149.—Ssbanajew-Franck Gastrostomy.
Cross section.

the avoidance of excessive bleeding, there are two other advantages gained by entering the stomach through a transverse incision, as follows: The approach to the pylorus is rendered much easier since retraction is only necessary on the distal side of the wound to expose freely the pyloric outlet. On the other hand, the ultimate scar formation which follows the healing of a longitudinal incision must narrow, more or less, the caliber of the zone involved, a possibility which should be wholly escaped by adopting the transverse opening. In non-malignant strictures of the pylorus much of the muscle has been replaced by connective tissue. Stretching of the inelastic scar has been recognized as dangerous, and, for this reason, abandoned. When pylorodiosis is done for spasm or for hypertrophy of the circular muscular fibers extreme caution is necessary in the introduction of the instrument in order to avoid tearing the mucous membrane, with resulting intractable bleeding. The left hand steadies the pylorus from the outside while the point of the instrument is delicately engaged with the right. After the outlet has been opened to slightly above its normal caliber the stomach is closed with two layers of sutures.

HAHN'S OPERATION.[1]

The chief advantage of Hahn's technic seems to be the exemption of the stomach from incision. This operation should not be done without gloves, else the nail on the entering finger may injure the peritoneum.

Steps:

(1) Pylorus steadied with left hand.

(2) Pylorus stretched by invagination of anterior wall on finger.

Unless the left hand holds the pylorus and the beginning of the duodenum it is obviously not possible for the right hand to exert the pressure necessary for this technic. The success of the method depends upon the muscular relaxation of that portion of the anterior wall invaginated on the finger. In case the muscular spasm reaches beyond the immediate vicinity of the sphincter, a wide margin should be taken from the contracted area. The finger is gradually pressed backward and to the patient's right, until the tip engages the orifice; it may be necessary to use the little finger for this purpose when the hole is very small. Steady pressure against the left hand gradually wedges the finger into the sphincter, when it is quickly substituted for a

[1] Hahn. Deuts. Med. Wochenschr., 1891, XVII, p. 913.

larger finger. Writers who have had experience with Hahn's operation are agreed that, to get the best after-effects, it is sufficient to introduce two fingers (Fig. 150).

FIG. 150.—PYLORODIOSIS, HAHN'S METHOD.

The right forefinger is wedging a fold of the anterior stomach wall into the pyloric outlet. The left hand steadies the duodenum.

OPERATIONS FOR NON-MALIGNANT STRICTURE OF THE PYLORUS.

Drainage of the stomach may be accomplished in one of several ways:

(1) Pyloroplasty (Heinecke-Mikulicz).

(2) Gastroduodenostomy.

- Finney's method.
- Kocher's method.

(3) Gastroenterostomy.

- Posterior method.
- Anterior method.

In the discussion of the mechanical indications for these operations pyloro-

plasty and gastroduodenostomy may be considered in the same class, although their clinical indications vary within certain limits. A mode of procedure adaptable to every case of obstruction of the pylorus has not been found; the technic must be chosen to meet the condition discovered at operation. In working upon the stomach of normal animals Cannon and Blake have demonstrated several new and important facts concerning the movements of the food in the stomach after various gastrointestinal operations. Their conclusions are quoted in full:[1]

"The stomach is not a passive bag. During digestion the cardiac end slowly contracts, pressing its contents into the pyloric end. Over the pyloric end during digestion peristaltic waves are continually running, churning the food with the gastric juices and forcing the chyme into the intestine. Observations on the functioning human stomach show that as it empties it shortens, especially along the greater curvature. Therefore the part of the stomach lowest when the organ is full or relaxed is not lowest as it empties. The pylorus then becomes the lowest point. Even if 'gravity drainage' occurred, the pylorus is the natural outlet so long as the stomach retains its power of contracting.

"The pressure within the abdomen is approximately atmospheric pressure. The pressure in any part of the passive alimentary canal depends on the weight of the overlying abdominal organs. If the canal is inactive, the food therefore is as if surrounded by water. Gravity cannot act, and gravity drainage does not occur.

"After an ordinary meal, the peristalsis of the pyloric end of the stomach makes the contents of this part more fluid than the contents of the cardiac end. Because peristaltic waves move toward the pylorus, the intragastric pressure is three or four times greater at the pylorus than in the cardiac end. Observations on large cats with gastroenterostomy openings of various sizes at various parts of the stomach showed that unless the opening, or stoma, was in the antrum—*i. e.*, close to the pylorus—the food, even when fluid, was pushed through the pylorus rather than through the stoma.

"With peristalsis only in the pyloric end of the stomach, with the intragastric pressure much greater at the pylorus than elsewhere in the stomach, and with the food in the pyloric end normally more fluid than that in the

[1] Cannon and Blake. Annals of Surgery, May, 1905.

cardiac end, the food is forced into the intestine through the pylorus and not through the artifical opening, when both ways are offered.

"Circulation of the food through the pylorus to the duodenum and back to the stomach through the anastomosis has been repeatedly observed, but it was not followed by the clinical symptoms of 'vicious circle.' The circulation was observed best when the stomach was very full. The stretching of the stomach separates the lips of the stoma and draws the intestinal wall into line with the gastric wall. The openings into the intestine at the stoma become mere slits, and act like valves, permitting the entrance, but preventing the exit, of the food.

"The clinical symptoms of the 'vicious circle' have been observed in animals in which a kink of the intestine has been found just distal to the anastomosis. Kinks at this point cannot be straightened by peristaltic activity because the circular fibers of the intestine are cut at the nearby stoma.

"It is important that food be mixed with the secretions poured into the duodenum. These are highly effective in digestion, and also neutralize the acid chyme. If food leaves the stomach by the stoma, it is not mixed with these secretions. Jejunal ulcers after gastroenterostomy may be due to the presence of acid in the region in which inorganic acid is not normally found.

"From the above considerations, it was concluded that the stoma should be large and as near to the pylorus as possible; that the circulation of the food be rendered less probable by avoidance of overeating, and that, so far as possible, kinks be obviated by attaching a narrow band of the distal gut to the stomach for several centimeters beyond the stoma, thus permitting peristalsis to become an effective force.

"The probability of a circulation of the food whenever the pylorus is left open, the non-mixture of the food with the digestive and neutralizing fluids in the duodenum, and the ever-present danger from kinks in gastro-enterostomy, make the operation not an ideal one.

"In pyloroplasty (preferably the Finney operation) these objections are avoided. And a too rapid exit of the food through the pylorus is prevented by rhythmic segmentation of the food in the duodenum, an activity which in part replaces the function of the pylorus, and also mixes the food with the pancreatic juice and the bile."

PYLOROPLASTY.

(HEINECKE[1]–MIKULICZ[2].)

This operation consists in enlarging the pyloric outlet of the stomach by means of incision and suture. It is done in certain cases where the caliber of the opening has become contracted as a result of benign disease, usually from scars following gastric ulcer. W. J. Mayo[3] states that, although the operation is attended with little risk, the technic has several deficiencies. It enlarges the caliber of the opening upward as well as downward in the line of drainage, while the extent to which this enlargement can be carried out is limited. Mayo has found that extensive adhesions commonly follow this operation, and in this manner the pyloric opening becomes permanently fixed at a high level. In cases where the muscle-fibers of the stomach are not capable of carrying out the normal peristaltic action, considerable difficulty may attend the effort to lift the food up through the highly-placed outlet. Mayo tried to overcome the difficulty just mentioned by fastening the pylorus in a lower position, but he does not advise the adoption of this method. Robson and Moynihan[4] do not favor the general use of this technic but reserve it for "string-like narrowing, or in spasm of the pylorus."

Steps:

(1) Exposure of pylorus, application of clamps.
(2) Horseshoe incision for division of stricture.
(3) Conversion of horseshoe into vertical incision.
(4) Opening sewed together in new position in two layers.

The abdomen is opened in the median line, and the pylorus exposed. After carefully walling off the field of operation with gauze, the pylorus is brought forward. In cases where the pylorus is held down by adhesions, this operation is said to be contraindicated. The clamps are applied as follows: On the stomach, the blades are placed directly across the pyloric portion, about three inches proximal to the stricture. The lower jaw of

[1] Heinecke. Ref. by Fronmuller. "Operation der Pylorusstenose," Inaug. Dissert., Furth, 1886.

[2] Mikulicz. Archiv für Klin. Chir., 1887, Bd. 37, S. 79.

[3] Mayo, W. J. Annals of Surgery, November, 1905.

[4] Robson and Moynihan. "The Surgical Treatment of Diseases of the Stomach," 1904, p. 265.

the clamp penetrates the gastrocolic omentum and lies beneath the stomach, in the lesser peritoneal cavity. On the duodenum, the clamp is placed about three inches distal to the stricture, at right angles to the long axis of the intestine. Mikulicz's incision is made parallel to the long axis of the pylorus and the duodenum, having the shape of a horseshoe, the arms of which extend over the stomach and the duodenum for about one inch on either side of the stricture (Fig. 151). Richardson[1] modifies this operation, in the presence of a dense stricture, by excising the thickened mass before uniting the cut edges. The redundant mucous membrane is cut away, as shown in Fig. 152. The second part of the operation consists in seizing the upper and the lower lips of the incision at their middle points. By drawing one edge upward and the other downward the incision is changed from a horseshoe curve into an irregularly vertical line. While held taut, either with guide stitches or with forceps in this new position, the cut is sewed up in two layers, as usual.

GASTRODUODENOSTOMY.

This operation consists in establishing an artificial outlet between the stomach and the upper portion of the duodenum. Kocher[2] first described the operation of gastroduodenostomy in 1891 when be joined the duodenum to the posterior wall of the stomach after resection of the pylorus. This gastroduodenostomy is not a lateral but an end-to-side technic. In 1892 Jaboulay[3] reported the first lateral anastomosis between the stomach and the duodenum. This is quite similar to the present operation, although many difficulties have been removed by later technical improvements. Henle,[4] Villard,[5] and Tixier[6] have since published cases and experimental work concerning gastroduodenostomy. These writers allude to freeing the duodenum to bring it into contact with the stomach, but give no particulars, other than to say that the technic is easy. As it is to this feature that the success of the operation is due, Jaboulay's method was comparatively little used until the anatomical question had been solved by later

[1] Richardson, M. H. Boston Med. and Surg. Journal, November 30, 1899.

[2] Kocher. Archiv für Klin. Chir., 1891, Bd. 42, p. 542.

[3] Jaboulay. Archiv. prov. de Chir., 1892, Vol. 1, p. 551.

[4] Henle. Cent. für Chir., 1898, Vol. XXV, p. 753.

[5] Villard. Lyon Médical, 1900, Vol. XCIII, p. 522.

[6] Tixier. *Ibid.*, p. 53.

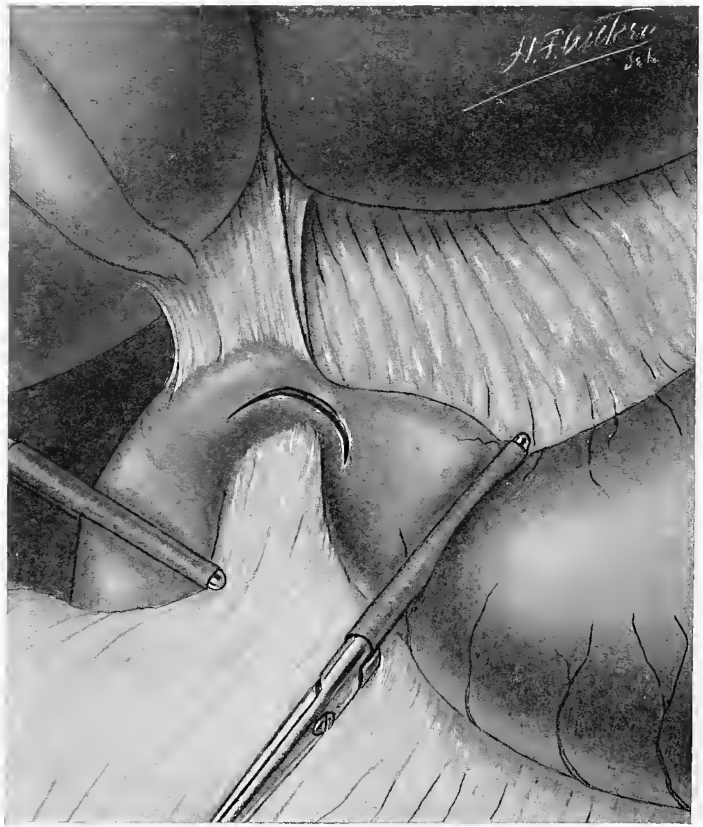

FIG. 151.—HEINECKE-MIKULICZ PYLOROPLASTY.
Stricture of the pylorus, the clamps applied, horseshoe incision.

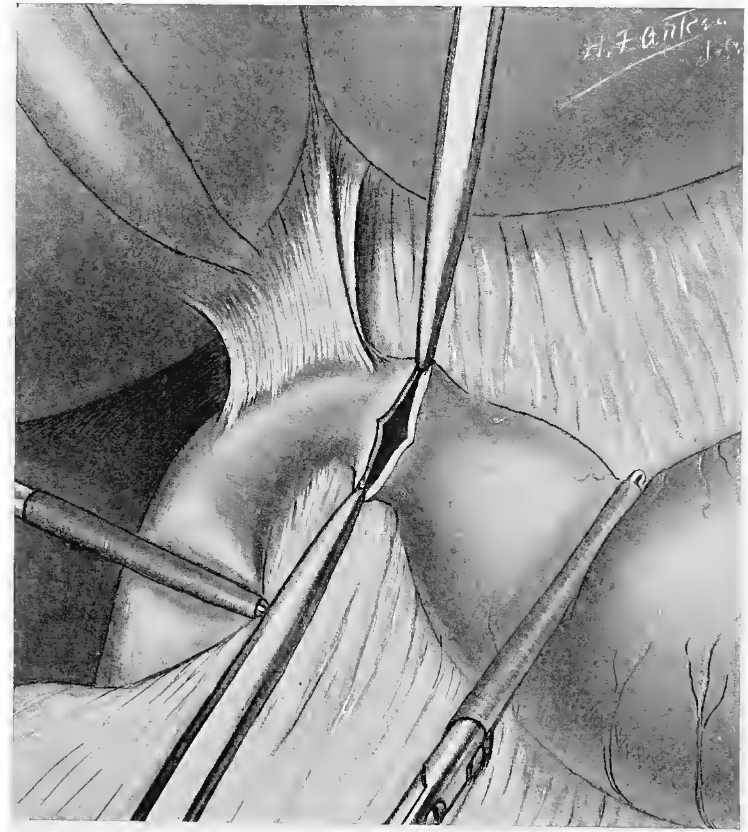

FIG. 152.—HEINECKE-MIKULICZ PYLOROPLASTY.
Incision now vertical, ready for suture.

observers. In 1902 Finney[1] described his operation, and gave the first account of a method of mobilizing the upper part of the duodenum. In the following year Kocher[2] published a similar scheme for loosening this portion of the small intestine as a preliminary step to his modification of Jaboulay's operation. The two methods of performing gastroduodenostomy to be described are known respectively as:

(1) Finney's operation.

(2) Kocher's operation.

FINNEY'S OPERATION.

This operation has for its purpose the enlargement of the pyloric outlet of the stomach. The incision is practically the same as that made for the Heinecke-Mikulicz pyloroplasty, the method of sewing together the wound being the distinguishing factor of Finney's technic. Properly the operation is a pyloroplasty, but it is classed here as a gastroduodenostomy in order to save space in the description of the mobilization of the duodenum, a step which it has in common with gastroduodenostomy. The researches of Cannon and Blake[3] showed that the best drainage of the stomach is obtained by attaching the intestine as near as possible to the pylorus. Finney's technic was recommended by these writers for this purpose; but there are several conditions which make the operation difficult or impossible. "Extensive disease, adhesions, a short gastrohepatic omentum, especially in the presence of scar tissue," should be regarded as contraindications of this operation (Mayo[4]). On the other hand, Finney[5] states that in three years' experience he has found no pyloric obstruction in which this operation could not be used.

In his original communication Finney made no mention of clamps, and his method has been modified by the author[6] in this respect, by animal experimentation, as given below:

[1] Finney. Bulletin Johns Hopkins Hospital, July, 1902.

[2] Kocher. Zeitsch. für Chir., January 10, 1903, No. 2, p. 33.

[3] Cannon and Blake. *Loc. cit.*

[4] Mayo, W. J. *Loc. cit.*

[5] Finney. Surgery, Gynæcology and Obstetrics, Chicago, Febuary, 1906.

[6] Gould, A. H. Boston Med. and Surg. Journal, January 5, 1905.

FIG. 153.—A VIEW OF THE RELATIONS OF THE POSTERIOR ABDOMINAL WALL. (SOBOTTA.)

The anterior abdominal wall and the anterior portion of the diaphragm have been removed by a frontal section. The stomach has been taken away between the cardia and the pylorus, exposing the lesser peritoneal cavity. The liver has been wholly removed. The parietal peritoneum has been denuded from the kidneys, part of the duodenum, the large vessels, and the musculature. The section shows the line of attachment of the mesocolon. Note relations of the duodenum.

Steps:

(1) Mobilization of the duodenum.
(2) Clamps.
(3) First seromuscular suture.
(4) Opening of stomach and duodenum.
(5) Inner through-and-through continuous suture.
(6) Clamps removed.
(7) Outer seromuscular suture.

A portion of Kocher's original article is quoted below which describes the mobilization of the duodenum:

"In intrauterine life the duodenum hangs free in the abdominal cavity (Merkel), and in childhood it still possesses considerable mobility. In later life its right side is directed toward, and becomes adherent to, the posterior abdominal wall, so that its anterior surface only is covered by the parietal peritoneum of the posterior wall of the abdomen. Even in the adult it may readily be demonstrated that the duodenum can be comparatively easily freed again, so that, as in the fetus, its descending portion and inferior flexure may be rendered movable and brought forward.

"To free the duodenum in this way it is necessary to divide the parietal peritoneum to the right of the descending part of the duodenum. The membrane is divided vertically over the front of the right kidney, a little to the left of the descending limb of the hepatic flexure of the colon. The parietal peritoneum stretches, in this situation, from the front of the right kidney to the colon, forming the upper layer of the transverse mesocolon. If the finger be passed upward along the second part of the duodenum, in front of the peritoneum covering the kidney, it will enter the foramen of Winslow, above the superior flexure of the duodenum and behind the free border of the gastrohepatic omentum, which contains the portal vein, the hepatic artery, and bile duct.

"We recommend that this delicate layer of parietal peritoneum be

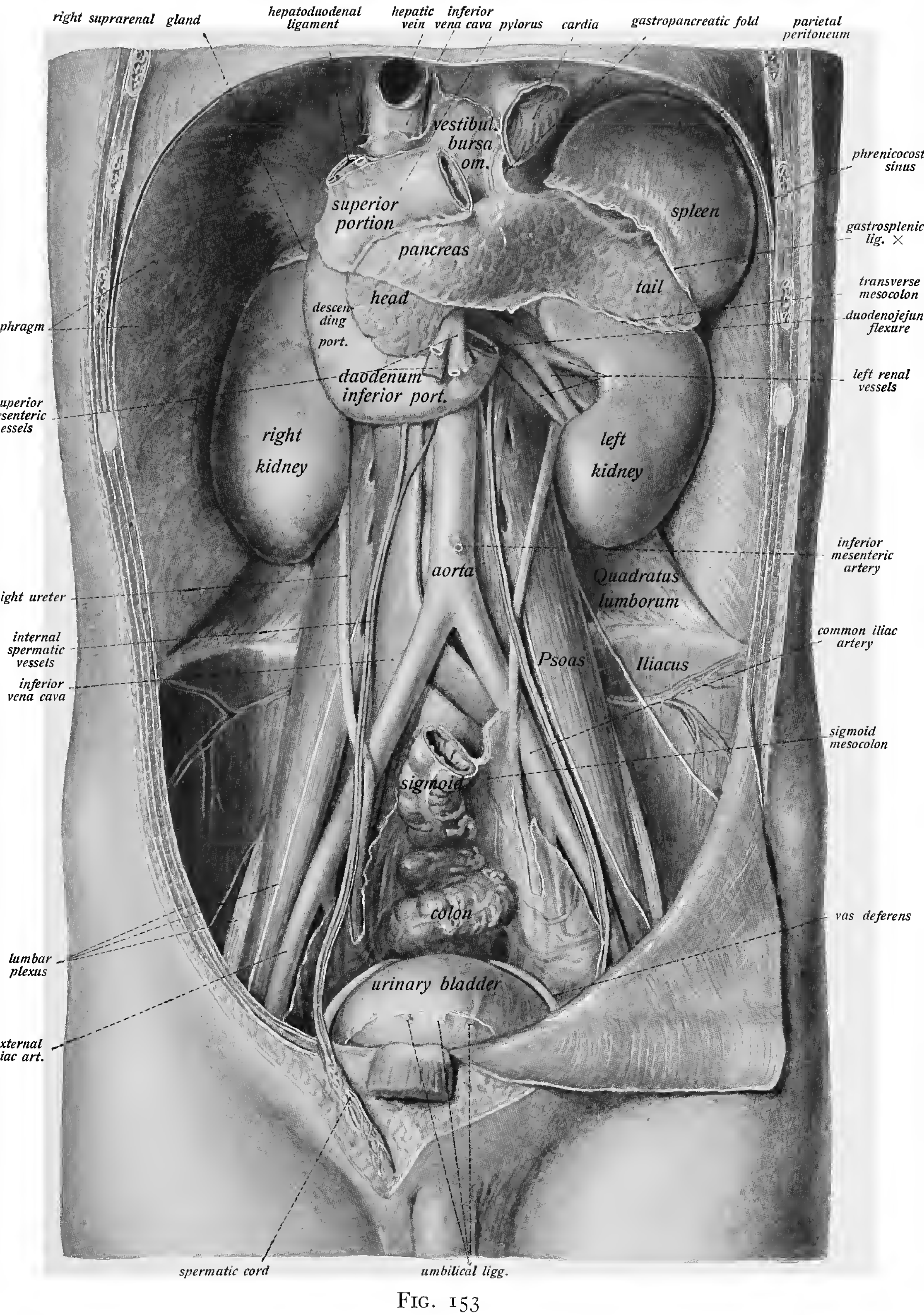
right suprarenal gland
hepatoduodenal ligament
hepatic vein
inferior vena cava
pylorus
cardia
gastropancreatic fold
parietal peritoneum
vestibul. bursa om.
superior portion
pancreas
spleen
phrenicocost sinus
gastrosplenic lig. ×
head
tail
transverse mesocolon
descending port.
duodenojejun flexure
phragm
duodenum inferior port.
left renal vessels
uperior senteric essels
right kidney
left kidney
aorta
inferior mesenteric artery
Quadratus lumborum
ight ureter
internal spermatic vessels
common iliac artery
Psoas
Iliacus
inferior vena cava
sigmoid mesocolon
sigmoid
colon
vas deferens
lumbar plexus
urinary bladder
xternal iac art.
spermatic cord
umbilical ligg.

FIG. 153

divided with the knife two finger-breadths to the right of and parallel to the second part of the duodenum, so that the peritoneum covering the anterior surface of the duodenum may not be injured, as would be the case were the peritoneum simply torn through.

"If the divided peritoneum adjacent to the second part of the duodenum be grasped and pulled forward, the fingers can then be introduced behind the duodenum so as to raise it from the vertebral column, the vena cava, and the aorta. If the peritoneum which descends toward the colon be also divided, the inferior duodenal flexure can also be raised up, not a single vessel of any size being injured. The head of the pancreas is raised up along with the duodenum so that the concave border of the latter, which must not be separated, becomes so movable that it offers no hindrance to the raising up of the duodenum.

"By this procedure the muscular coat of the posterior surface of the duodenum is not laid bare, being covered by a layer of connective tissue.

"By the above manipulations the second part of the duodenum is rendered so movable that it can be easily brought up to the anterior surface of the pyloric portion of the stomach above the greater curvature.

"The extent to which the duodenum can be freed depends on the arrangement of the vessels. The right gastroepiploic artery (the main branch of the gastroduodenal artery) gives off important branches which pass from the left concave border of the duodenum across its transverse (third) part to the transverse colon. These vessels, which lie behind the upper layer of the gastrocolic ligament, do not interfere to any extent with the raising of the duodenum from the vertebral column. If the colon be thrown upward the large colic artery will be seen crossing in front of the duodenum and then running along its lower margin to reach the ascending colon and the hepatic flexure. While these vessels are not so easily displaced to the left as the branches which go to the colon from the right gastroepiploic vessels, they nevertheless do not prevent the inferior flexure of the duodenum from being sufficiently freed to allow the whole of its descending portion to be raised up from the vertebral column into a convenient position for suturing. The duodenum and the stomach, before being opened, must be grasped between the fingers above and below the intended line of suture so that escape of contents may be prevented.

"The part of the duodenum that can be least freed is the superior flexure, because to it is attached the gastrohepatic omentum containing the important vessels already mentioned. This ligament, and its prolongation downward along the concave border of the duodenum on to the head

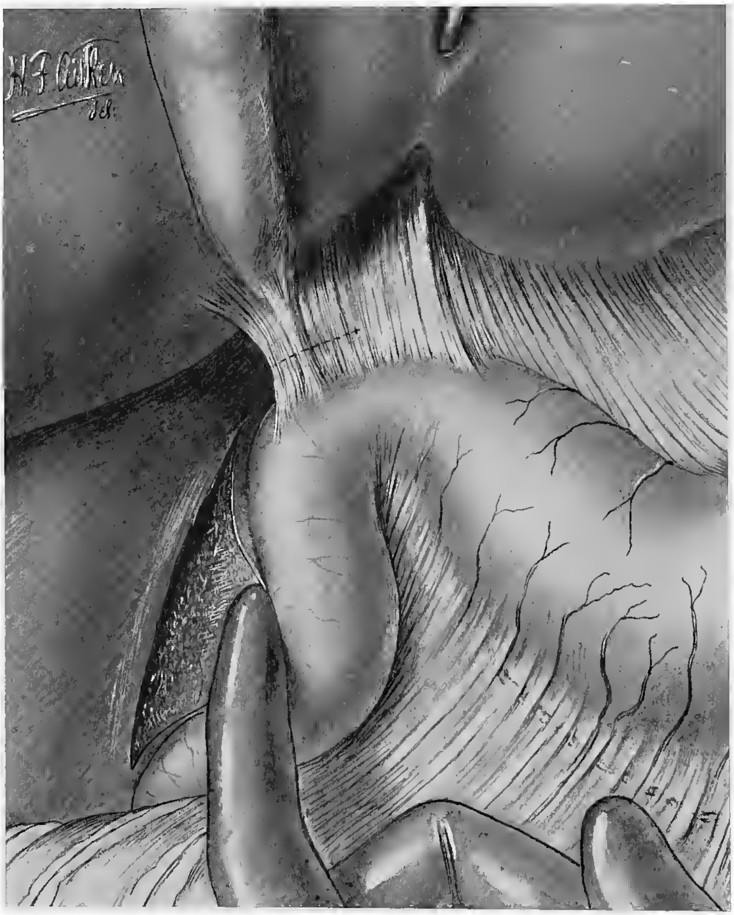

FIG. 154.—MOBILIZATION OF THE SECOND PORTION OF THE DUODENUM. (FINNEY-KOCHER METHOD.) Note vertical peritoneal incision parallel to and to the right of the second portion of the duodenum. The duodenum is being shelled out with the finger. Also note the dotted line on the edge of the lesser omentum. A superficial cut through the omentum at this point allows the pylorus to drop down, thus assisting in the mobilization of the duodenum.

of the pancreas, forms an axis around which the descending limb and inferior flexure of the duodenum can be rotated forwards. The lower end of the axis of rotation is determined by the vessels which descend vertically across the terminal portion of the duodenum, and which do not

interfere with the raising up of the inferior flexure and the adjacent portion of the third part of the duodenum."

As an addition to the above procedure Finney suggests the division of the suspensory ligament of the pylorus which anchors the upper flexure of the duodenum whenever it is difficult to draw the pyloric angle downward to a sufficient degree to allow the anastomosis to be carried out. After the division of this peritoneal fold the pylorus can be brought down

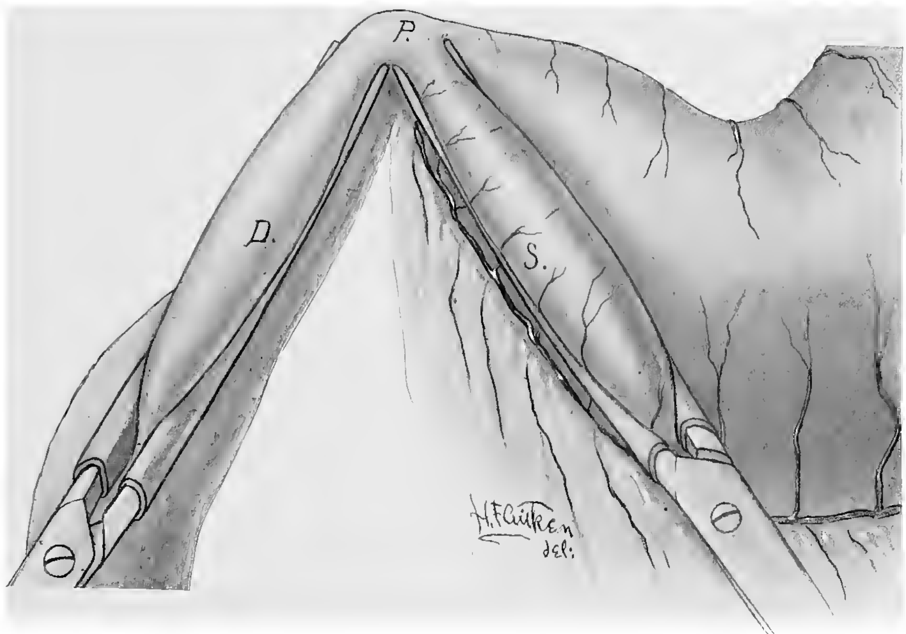

FIG. 155.—FINNEY'S GASTRODUODENOSTOMY.

Note application of clamps. On the stomach they are placed parallel with the greater curvature, thus controlling the hemorrhage from the vessels which are seen crossing the line of the future incision. Inner jaws of both clamps touch at the pyloric angle. When the handles are brought together, the pyloric angle (P) is put on the stretch. It can be seen that the use of guides is unnecessary to make the folds lie side by side.

within easy reach (Fig. 154). The length of duodenum which it is required to mobilize for this operation is not constant, but it will usually be found necessary to free two or three inches before the duodenum will lie easily beside the stomach. When the duodenum is sufficiently freed clamps are applied (Fig. 155). On the duodenum a fold of bowel about two and one-half inches long is taken up, longitudinally, and the clamp pushed up until the inner jaw rests against the pyloric sphincter. On the

stomach the clamp is placed in a similar manner, the point of the inner jaw touching that of the duodenal clamp at the pylorus. The ends of the clamps are not freed, but grasp the bowel half an inch below the free edge. This places the clamps at right angles to the blood-vessels both of the stomach and of the duodenum. When the handles of the two clamps are brought together, the pyloric angle is put on the stretch, thus controlling hemorrhage, and preventing leakage from this inaccessible point. If the

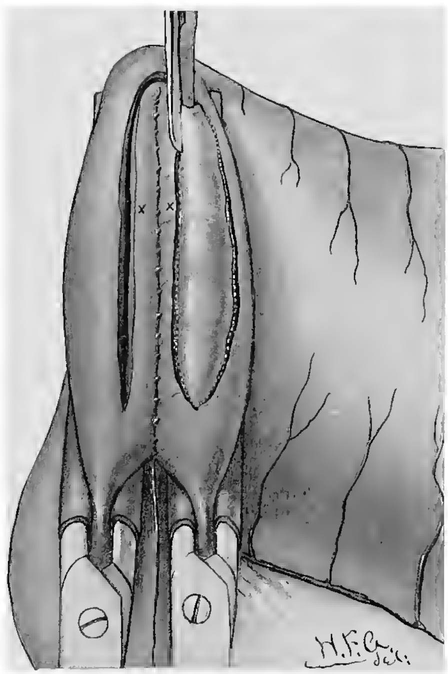

FIG. 156.—FINNEY'S GASTRODUODENOSTOMY.

Clamps are now side by side. Folds approximated by a continuous seromuscular stitch. Stomach incised to mucous membrane; duodenum then opened freely to pyloric angle. Scissors now cutting out redundant mucous membrane along dotted line. The next step is to sew x to x, beginning at the pyloric end of the tongue.

clamps are placed in the manner recommended above, the remainder of the operation will practically amount to a repetition of the gastroenterostomy technic, described later. The folds are fastened together, as they lie side by side, by the usual outer seromuscular stitch. This stitch starts at the pyloric angle to make sure that this point is placed at the apex of the tongue to be cut out later. The incisions into the bowel and the stomach are like those of a gastroenterostomy, except that they are joined at one

end, an addition which is made possible by the continuity of the two organs. The stomach incision is carried down until the mucous membrane pouches between the cut muscular walls. The stomach incision is then left, and the duodenum opened, until the mucous membrane is met at the pyloric angle (Fig. 156). The pouching mucous membrane is removed from the stomach by cutting with scissors close to one muscular edge, returning on the other side. The completed incision leaves a tongue-like process made up of half stomach and half intestinal walls. The two edges of the tongue are next sewed together with a continuous through-and-through chromic stitch, which starts at the apex of the tongue and goes across the cut to the base (Fig. 157). At this point the suture is interrupted with a tie,

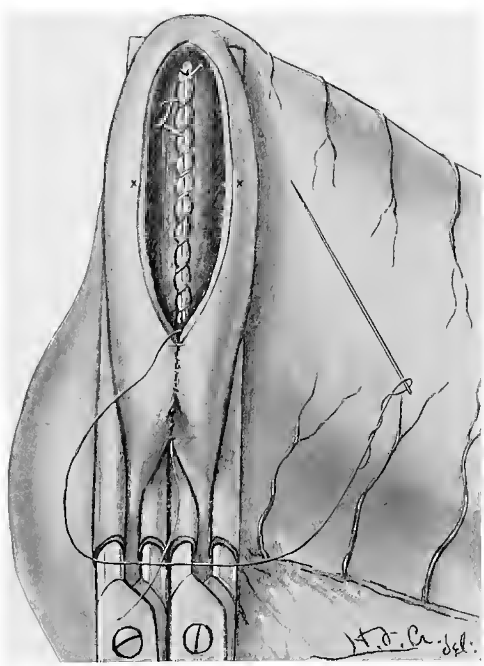

FIG. 157.—FINNEY'S GASTRODUODENOSTOMY.
Tongue (T) now closed over by continuous stitch, which has turned corner to finish front of suture, bringing X to X. This line of suture is finally buried in by a seromuscular stitch.

after which the suture is continued around over the front and tied at the pyloric angle. It is necessary to loosen the clamps before placing the last few stitches of this suture, since this area is under too great tension to allow the edges to be brought together. Finney[1] closes in the front of the joint

[1] Finney. Surgery, Gynæcology and Obstetrics, February, 1906.

with a series of mattress stitches placed before the incision is made. He finds this method to be preferred over the running stitch for closing in the front of the joint. The clamps are, finally, removed altogether and the suture buried in with a continuous seromuscular suture. If this opera-

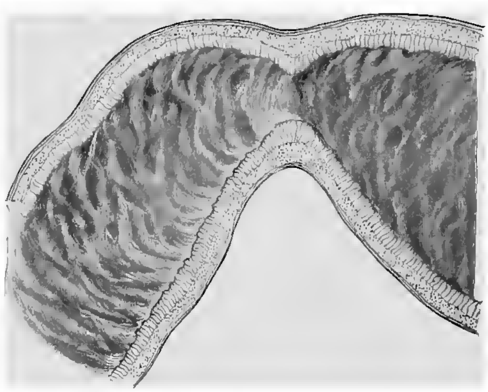

FIG. 158.—FINNEY'S GASTRODUODENOSTOMY.
Cross section of pylorus and duodenum before operation, for comparison with Fig. 159.

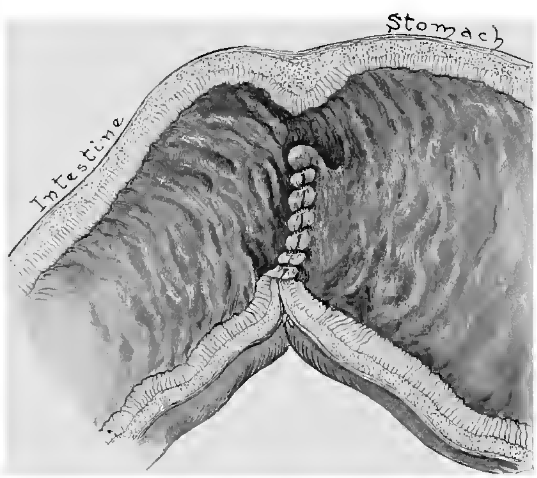

FIG. 159.—FINNEY'S GASTRODUODENOSTOMY.
Cross section after operation, showing increase in caliber of pylorus; caliber increased over Fig. 158 by length of sewed edges.

tion is done without clamps, or if they are placed across the pylorus, the tongue, referred to above, will protrude between the edges of the wound and will thus hinder the suture over the front. If the clamps are placed as recommended here, this tongue will cause no more trouble

than is experienced from the lower cut edges of a gastroenterostomy. As to the length of the incisions into the stomach and the duodenum, the usual size of the pyloric outlet should be fully restored, with a slight over-correction to allow for the possibility of a future contraction.[1] The openings made in the early cases, where this technic was followed, were usually larger than necessary, and have occasionally been followed by unpleasant symptoms, possibly due to the regurgitation of bile into the stomach. (Figs. 158 and 159 are cross sections.)

The actual mechanical result of carrying the incision far down over the duodenum is not to increase proportionately the caliber of the outlet, for this can never be made larger than the diameter of the duodenum; but it converts the attached portion of the duodenum into a sort of extension of the pyloric portion of the stomach, leaving the duodenal outlet pointing downward at a right angle with the long axis of the stomach.

KOCHER'S GASTRODUODENOSTOMY.

This operation is a lateral anastomosis between the pyloric portion of the stomach and the second or descending portion of the duodenum. Kocher has found that the operation is contraindicated when adhesions are present between the duodenum and the under surface of the liver.

Steps:

(1) Mobilization of the duodenum.
(2) Clamps.
(3) Lateral anastomosis.

Kocher explains the technic as follows:

"After what has been said regarding the freeing of the duodenum, the following will suffice to describe our method of performing gastro-duodenostomy. The most suitable incision is one similar to that which we recommend for exposing the gall bladder,—viz., an oblique incision two finger-breadths below and parallel to the right costal margin, beginning at the middle line. After dividing the skin and fascia the rectus muscle is cut through as far as the broad abdominal muscles. The posterior layer of the rectal sheath, the fascia transversalis, and the peritoneum are divided. In muscular subjects the transversalis muscle is split parallel to its fibers,

[1] Finney makes the opening about 10 cm.

which are then firmly drawn apart. Should any adhesions exist between the gall bladder and the colon they must be divided. The liver is drawn upward, the stomach to the left, and the transverse colon and the descending limb of the hepatic flexure downward. The duodenum is then brought into view and its outer border is clearly defined. A pad of gauze is placed against the under surface of the liver, and the latter is then drawn well upward with a suitable retractor. Gauze compresses are also employed to push aside the stomach and colon.

"The delicate layer of parietal peritoneum covering the kidney is divided vertically one and one-half inches external to the second part of the duodenum, and the incision is then continued vertically downward through the upper layer of the transverse mesocolon (which is held on the stretch) as far as the large branches of the vessels. The fingers are then introduced behind the left edge of the incision through the peritoneum, and the duodenum is separated from the vertebral column, the vena cava, and the aorta, until it can be brought forward and pressed against the pyloric portion of the stomach, which, in its turn, is compressed against the left edge of the wound in the abdominal wall so as to shut off the general cavity of the stomach and prevent escape of its contents. Both stomach and duodenum are now compressed above and below between the fingers of an assistant, and the lateral anastomosis is effected in the usual manner by two rows of sutures."

Kocher gives no account of the technic for placing the clamps. The point of application of the clamps should be as near to the pylorus as the local conditions will allow. On the stomach the clamp is placed parallel to, and about half an inch from the greater curvature. On the duodenum the clamp is placed on the free border, parallel to the long axis of the intestine (Fig. 160). The remainder of the technic is that of the ordinary lateral intestinal anastomosis.

Krause's clamps are especially useful for this operation, since the full curve of the blades will make their application easier in cases where the field of operation is difficult to approach.

C. A. Porter[1] has successfully anastomosed the duodenum to the lesser curvature of the stomach, by a modification of Kocher's technic, in a case where the greater curvature was involved.

[1] C. A. Porter. Unreported case.

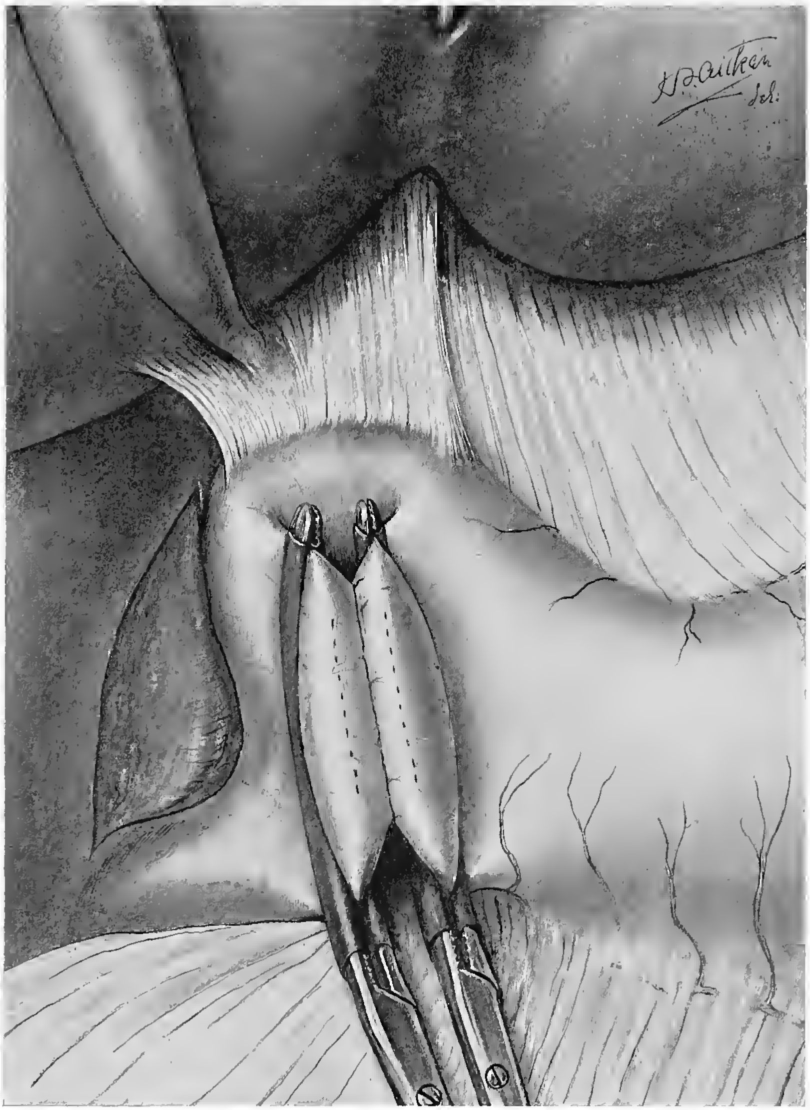

FIG. 160.—KOCHER'S GASTRODUODENOSTOMY.

The duodenum has been loosened and drawn inward. Krause's clamps are useful here on account of their full curve. Dotted line shows site of the anastomosis.

GASTROENTEROSTOMY.

(1) Posterior method.

(2) Anterior method.

This operation consists in the establishment of an artificial opening between the stomach and some part of the intestinal canal. The use of the term is now practically limited to the anastomosis of the stomach with the jejunum. It is hardly fair to quote opinions upon the subject of gastro-enterostomy, since this operation is still the center of experiment and discussion. Without committing any surgeon to the advocacy of this technic, it may be said that its elaboration has been largely due to the work of Wölfler, von Hacker, Peterson, the Mayos, Moynihan, Littlewood, Robson, Munro, and others.

POSTERIOR GASTROENTEROSTOMY.

(Von Hacker.[1])

Steps:

(1) Great omentum and transverse colon lifted out of the abdomen to expose under surface of mesocolon.

(2) Mesocolon opened over lowermost point of stomach, and posterior wall of stomach pushed through opening with fingers of left hand.

(3) Clamps, stomach and jejunum; walling off.

(4) First half of seromuscular stitch.

(5) Incisions into stomach and jejunum.

(6) Inner through-and-through catgut stitch.

(7) Clamps loosened, one removed.

(8) Second half of seromuscular stich, over front; second clamp removed.

(9) Cut edges of mesocolon sewed to stomach.

The abdomen is opened about three-fourths inch to the right of the middle line, through the rectus muscle. The stomach is brought forward out of its bed, lifted, with the transverse colon and the greater omentum, out of the abdomen, and turned over the upper angle of the abdominal incision.

[1] Von Hacker. Wien. Klin. Wochenschr., 1890, III, 348; Verhandl. d. Deutsch. Gesellsch. für Chir., 1885.

FIG. 161.—Front view of the relations of the great omentum and the stomach. (Sobotta.)

FIG. 162.—The great omentum turned up exposing the small intestines. The transverse colon is undisturbed. (Sobotta.)

FIG. 163.—Transverse colon lifted up over the thorax. Small intestine falling to one side, disclosing the duodenojejunal flexure, with the ligament of Treitz. Note the colica media artery. (Sobotta.)

FIG. 164.—The small intestine cut off between the beginning of the jejunum and the cecum. Note the cut mesenteric edges of the small intestine, the vessels, and the large intestine. (Sobotta.)

This exposes the under surface of the transverse mesocolon, in which are seen ramifying the vascular arches of the colica media artery (Figs. 161, 162, 163, and 164). The fingers of the left hand now grasp the point on the greater curvature which is lowermost when the stomach is in its normal relations within the abdomen. By pressing firmly upward on the posterior wall of the stomach with the fingers of the left hand the mesocolon is made to bulge over the point at which the anastomosis is to be made. A bloodless spot is chosen, and a small incision made through the mesocolon, in a direction at right angles to that of the long axis of the transverse colon. Moynihan[1] finds it of advantage to seize a small portion of the mesocolon with forceps, at a point near the spot selected for opening, in order to draw the mesocolon away from the posterior wall of the stomach while the incision is being made. Some difficulty is occasionally experienced in gaining entrance into the lesser peritoneal cavity when adhesions are present between the mesocolon and the stomach. Under these circumstances the mesocolon should be separated by blunt dissection from the stomach for a sufficient distance to allow room for the anastomosis. When this separation cannot be done with safety, the anastomosis must be made on the anterior wall. The fingers are now slipped into the lesser sac, and the incision gradually enlarged, by tearing and stretching, to an opening about three inches in length. Occasionally it may be necessary to tie a small artery at the edge of the mesocolic incision. Continued pressure with the left hand at the point grasped earlier in the operation will present the posterior wall of the stomach at the window in the mesocolon, where the stomach is grasped and pulled well through. Moynihan's line of incision is made obliquely from above downward and to the right, on an imaginary line drawn between two points which are, respectively, the middle of the dome, and the lowermost point on the greater curvature of the stomach. This lowermost point is, however,

[1] Moynihan. The Practitioner, London, 1904, LXXII, p. 251.

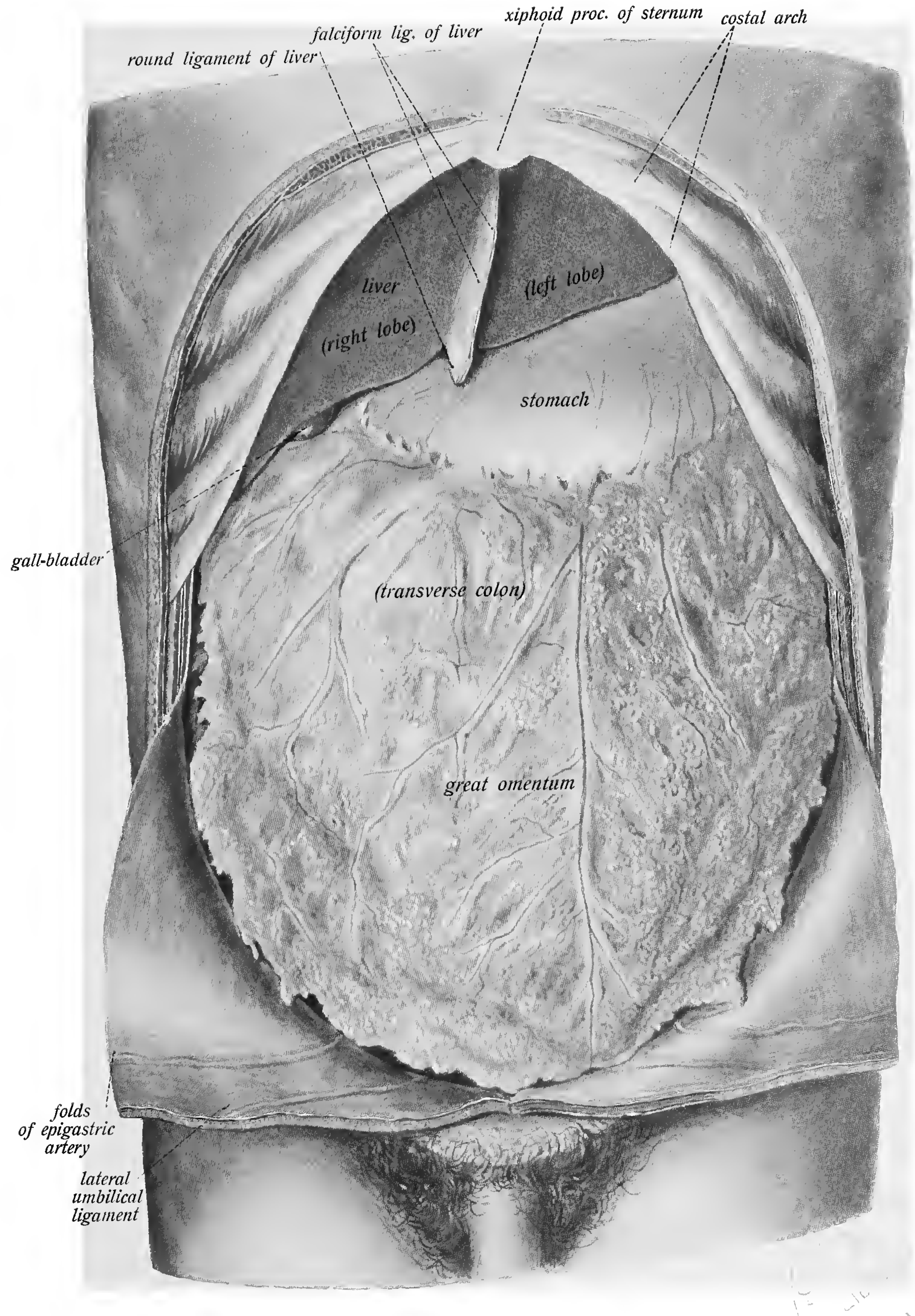
xiphoid proc. of sternum
costal arch
falciform lig. of liver
round ligament of liver
liver
(right lobe)
(left lobe)
stomach
gall-bladder
(transverse colon)
great omentum
folds
of epigastric
artery
lateral
umbilical
ligament

FIG. 161

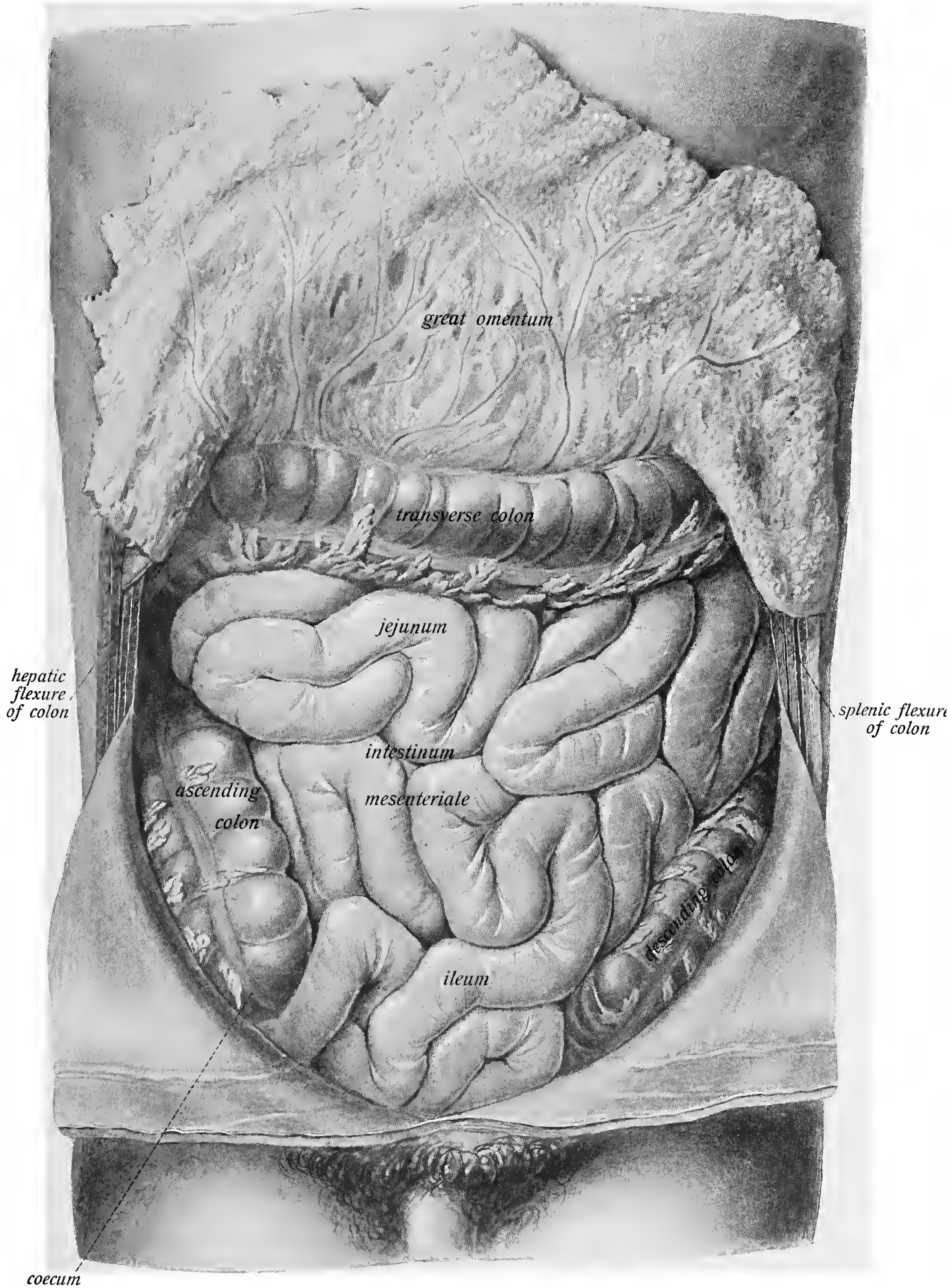
great omentum
transverse colon
jejunum
hepatic flexure of colon
splenic flexure of colon
intestinum mesenteriale
ascending colon
descending colon
ileum
coecum

FIG. 162

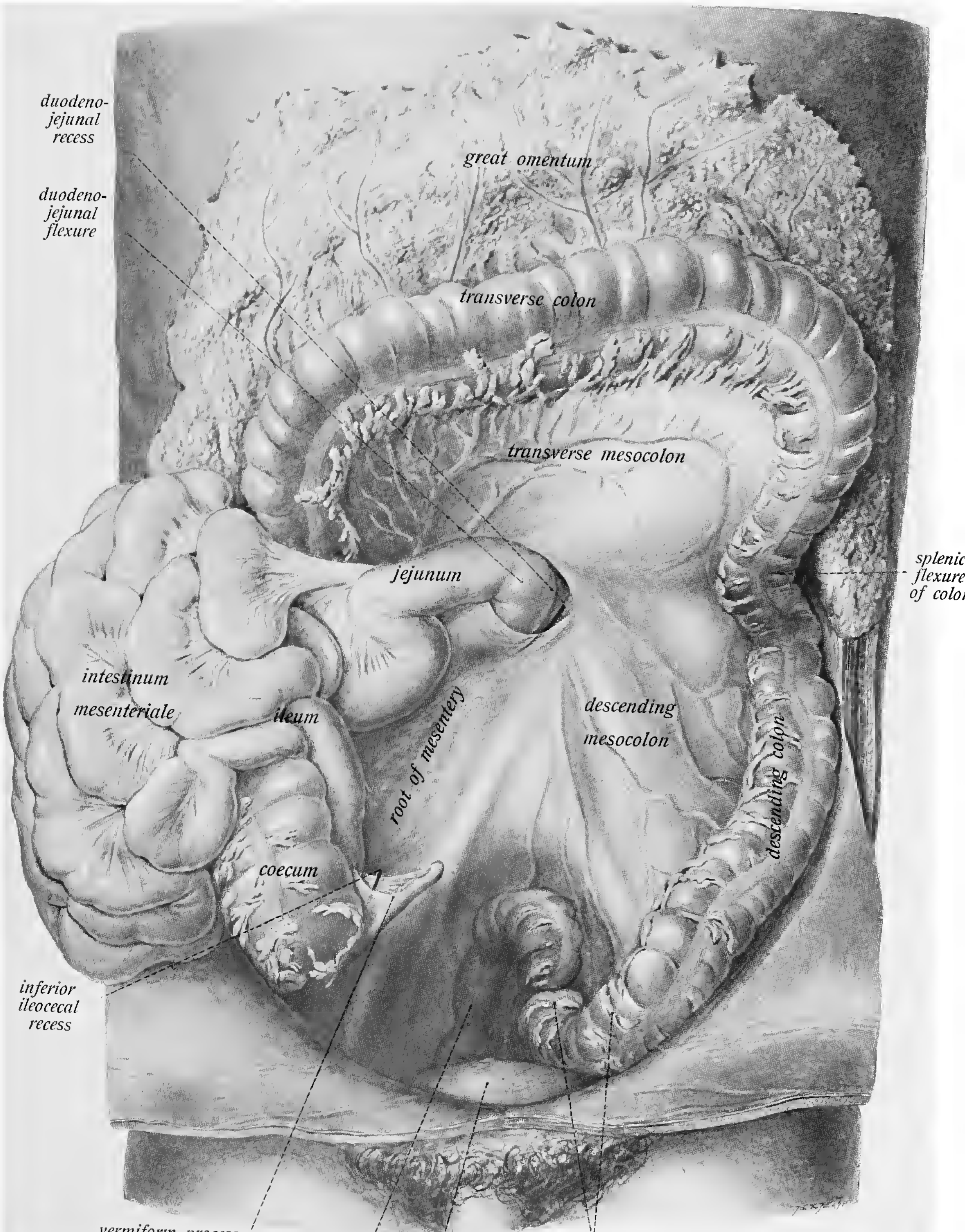
duodeno-
jejunal
recess
duodeno-
jejunal
flexure
great omentum
transverse colon
transverse mesocolon
splenic
flexure
of colon
jejunum
intestinum
mesenteriale
ileum
root of mesentery
descending
mesocolon
descending colon
coecum
inferior
ileocecal
recess
vermiform process
rectum
urinary bladder
sigmoid colon

FIG. 163

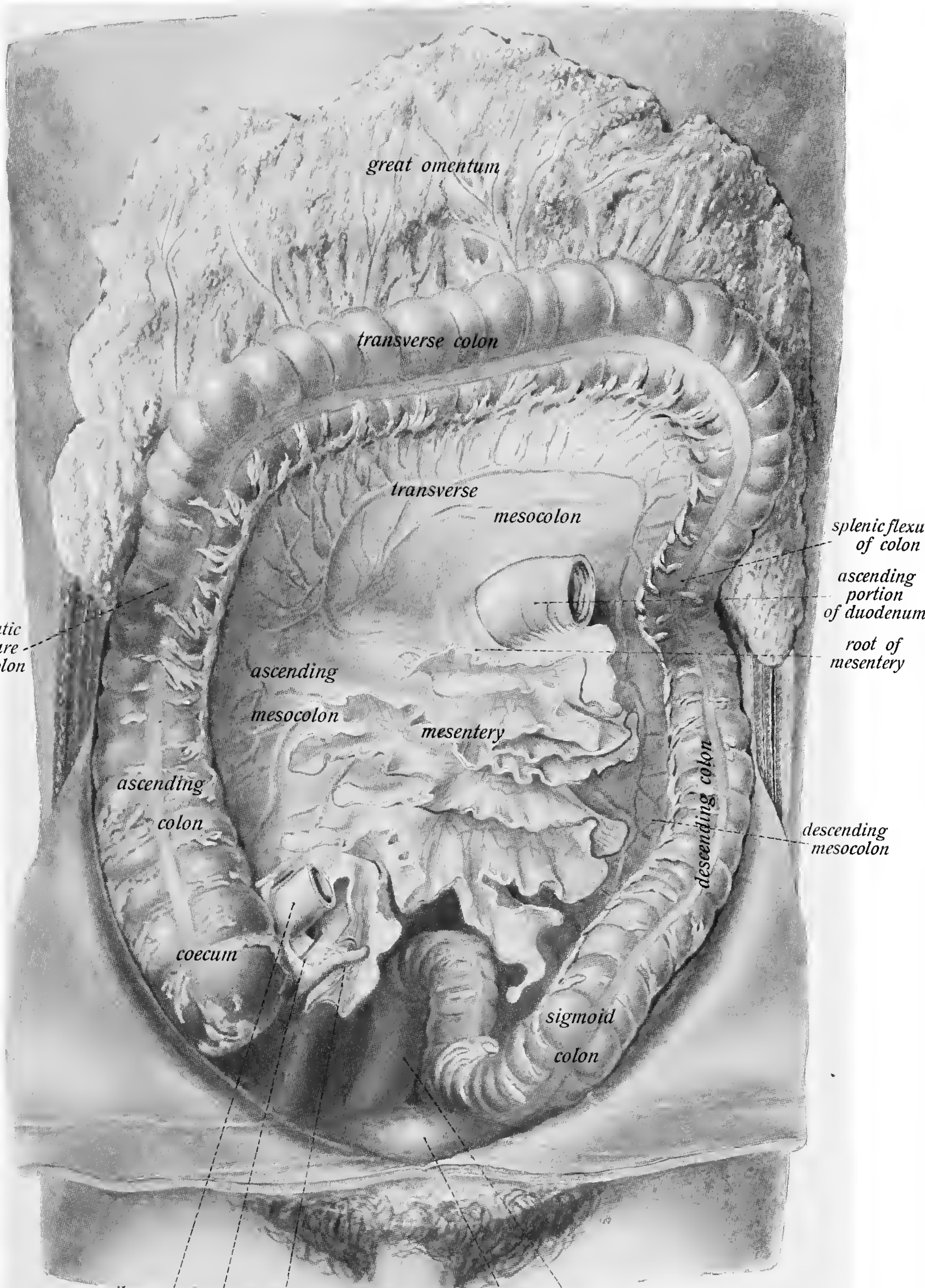
great omentum
transverse colon
transverse
mesocolon
splenic flexure
of colon
ascending
portion
of duodenum
root of
mesentery
hepatic
flexure
of colon
ascending
mesocolon
mesentery
ascending
colon
descending colon
descending
mesocolon
coecum
sigmoid
colon
ileum
inferior ileocecal fossa
vermiform process
urinary bladder
rectum

FIG. 164

a variable one, according to whether the stomach is at rest or in motion (Cannon and Blake).[1] In the resting stomach the lowest point is found almost exactly beneath the angle formed by the bending of the vertical portion of the lesser curvature to the right to become the upper border of the

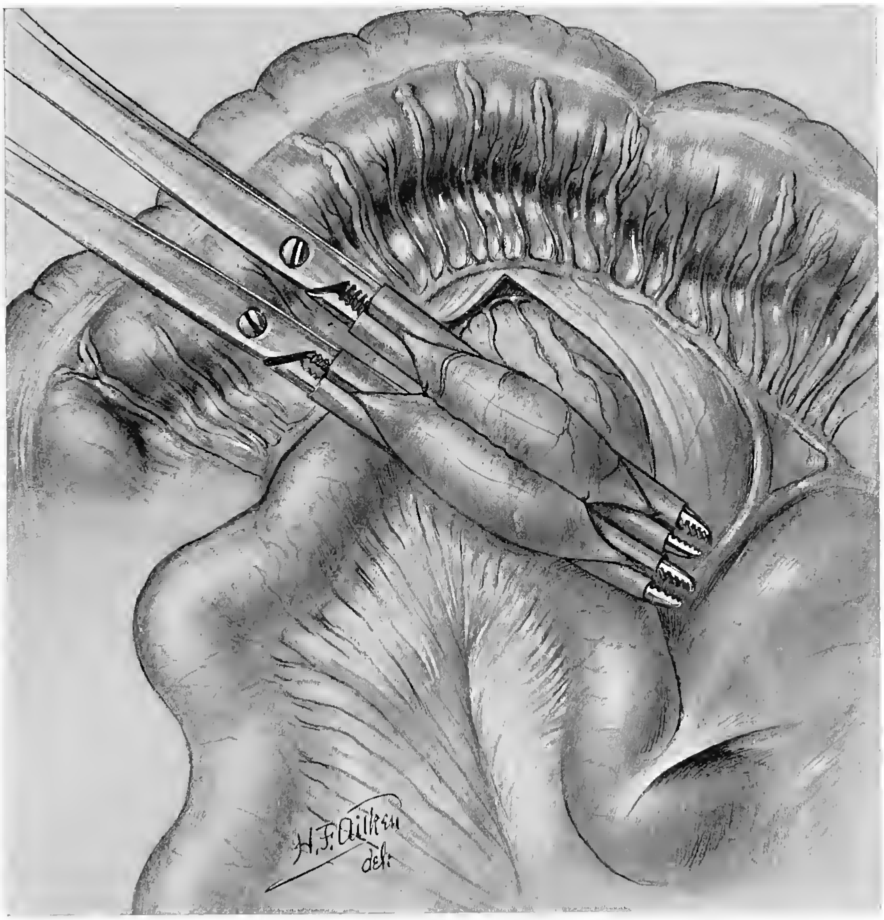

FIG. 165.—POSTERIOR GASTROENTEROSTOMY.

The clamps have been applied about three inches distal to the duodenojejunal flexure. The blades of the stomach clamp have been placed obliquely (Moynihan), while the handles point to the patient's right shoulder (Mayo, Munro). (Drawn according to suggestions from W. J. Mayo.)

pyloric portion.[2] This point is placed at a distance of from two to three inches to the left of the pyloric sphincter. A fold of the posterior wall is picked up on Moynihan's line with two pairs of forceps, the lower end of

[1] Cannon and Blake. *Loc. cit.*
[2] Mayo, W. J. Annals of Surgery, November, 1905.

which fold includes a small portion of the greater curvature (Fig. 165). When the clamp is applied to this fold, the tips of the blades point to the outer side of the patient's left hip, and the handles to his right shoulder (W. J. Mayo).[1] Mayo carries the gastric incision to the very bottom of the stomach, as seen at rest, thus necessitating a separation of the greater omentum from the posterior wall of the stomach for a short distance at this point. The experiments of Cannon and Blake, alluded to above, have shown that the lowest point of the stomach is not a fixed one, but changes rapidly as the peristaltic waves pass along from the fundus toward the pylorus.

In view of these valuable experiments, it seems unnecessary to carry the incision to the very bottom of the resting stomach. On the other hand, in performing a gastroenterostomy, it is desirable to leave the beginning of the jejunum and the posterior wall of the stomach as nearly as possible in their natural relations, after completing the anastomosis,—an anatomical advantage which is distinctly offered by Moynihan's line of incision. In cases where an enteroenterostomy is done, between the proximal and the distal jejunal coils (Braun[2] and Jaboulay[3]), the incision should be made parallel to the greater curvature, as the natural anatomical relations will be changed by the downward traction of the anastomosis below. The identification of the beginning of the jejunum is accomplished by sweeping the finger along the under surface of the attachment of the transverse mesocolon to the posterior abdominal wall. The intestine will be found just to the left of the spine, as seen in the anatomical plates, whence it is hooked up on the finger, and brought out of the abdomen. The point chosen for the jejunal opening is, necessarily, variable. While the stomach lies outside of the abdomen, it is possible to perform the anastomosis close to the duodenojejunal flexure, as recommended by Peterson.[4] Before attaching the jejunum, however, to the stomach, an examination should be made to determine the position of the greater curvature, while lying at rest, within the abdomen. If the loop of jejunum be too short (*after the stomach is replaced*), a sharp downward kink will follow at the duodenojejunal flexure,

[1] Mayo, W. J. *Ibid.*

[2] Braun. Cent. für Chir., 1892, Vol. XIX, p. 102.

[3] Jaboulay. Archiv prov. de Chir., T. I, No. I, p. I.

[4] Peterson. Beiträge zur Klin. Chir., XXIX, 1900, 1901, p. 597.

which may cause pain or obstruction. The jejunum is now seized with the left hand, about four or five inches from the duodenojejunal flexure, and put on the stretch, by pulling upward and to the right (Moynihan).[1] The clamp then grasps a fold on the free border approximately three inches in length, the nearest point of which fold is three or four inches from the beginning of the jejunum. The handles of the two clamps are brought side by side, and the transverse colon, great omentum, and the portions of the stomach and the jejunum not included in the clamps are returned into the abdomen. The field of operation is walled off from the abdomen as follows: A small sponge is tucked between the coils, and around and under the clamps is wound a handkerchief gauze; over all is laid a dry towel. A continuous seromuscular stitch is first introduced, which begins at the left and ends at the right extremity of the clamped folds, the operator standing on the patient's right. A curved needle is useful for the first layer of the sutures. The thread is left long at the right end of the first seromuscular suture, to be used later in closing in the front of the joint. The length of this outer layer of stitches should be at least three inches, depending upon the size of the stoma desired. Incisions are now made into the stomach and the jejunum with a knife, about one-fourth inch to either side of the first seromuscular stitch. As the cuts are made, the serous and the muscular coats retract, and the mucous layer pouts into the incision. Care should be taken to cut straight toward the center of the gut lumen in order to avoid dissecting the submucosa from the mucosa. The ellipse of mucous membrane protruding into the incision is cut away with scissors, following the edge of retracted muscle (Fig. 156). By pulling the mucous membrane taut with forceps, and taking short, rapid bites with the scissors,[2] a clean-cut edge of mucous membrane will result, which does not retract. Moynihan[3] advises dissecting the muscle free from the underlying layer, and preventing the retraction of the latter by miniature vulsella forceps. From an experimental point of view it would seem undesirable to trim away an excessive amount of mucous membrane, since the object of the trimming is to give a clean-cut edge for sewing,

[1] Moynihan. *Loc. cit.*

[2] Littlewood. London Lancet, November 3, 1900, p. 1276.

[3] Moynihan. *Loc. cit.*

and to avoid the possibility of obstruction by valve formation of the redundant tissue. On the other hand, if the trimming is carried to excess the mucous membrane will be under great tension after the suture is completed, thus resulting in a wide ulcer, which must delay the repair.

The cut edges of the intestine and the stomach are now united with a continuous through-and-through suture of No. 0 chromic gut. It is customary to begin this stitch at one angle of the wound, and sew straight

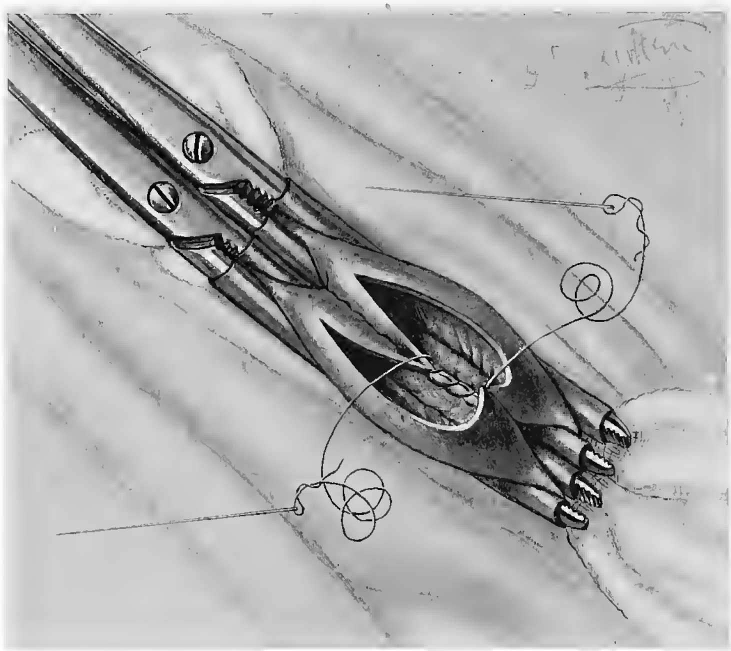

FIG. 166.—POSTERIOR GASTROENTEROSTOMY.

The stomach and the jejunum have been opened and the inner layer of through-and-through sutures begun, one corner having just been turned. Note that the field has been walled off with a towel, while a small sponge has been slipped between the two clamps. Beneath the towel has been wound a handkerchief gauze.

across the base, around the second angle, and over the front. There is a distinct advantage, however, as pointed out previously by the author, in turning both corners without stopping, to avoid, as far as possible, all danger of leakage. The inner stitch is, therefore, begun in the middle of the base line and tied in the middle of the thread. From the first knot the suture goes outward toward each corner, piercing all coats, over and over. The first corner is reached and just turned, and here the thread is tied, and

left long. After this, the suture begins with the long end left at the first knot, and goes outward to the second corner, which it turns, and, after crossing over the front, is tied to the end left near the first corner. This method avoids tying the last knot deep in the angle of the wound (Fig. 116).

As no leakage can now occur, the clamps are unfastened and one entirely removed, while the other clamp is left in place with the jaws open, as

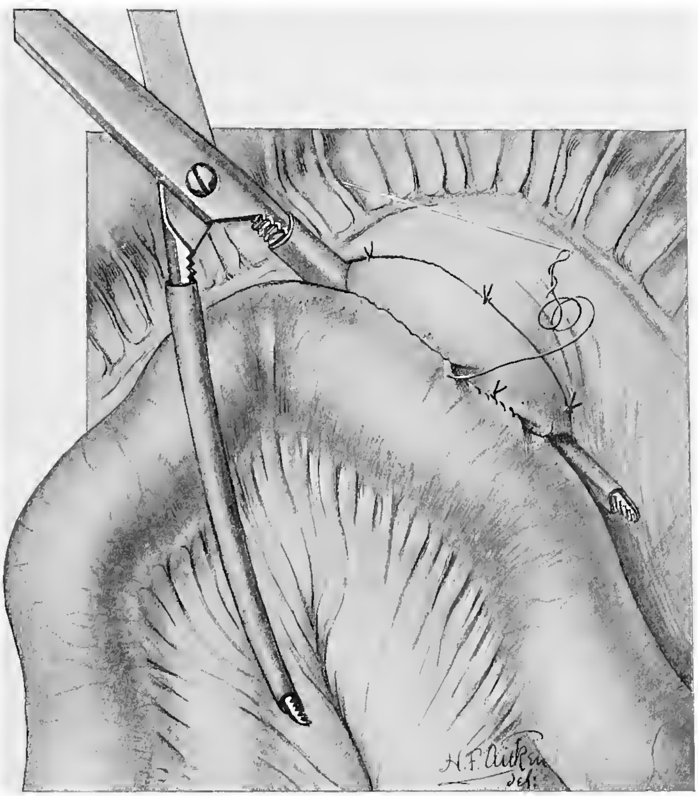

FIG. 167.—POSTERIOR GASTROENTEROSTOMY.

The gastroenterostomy has been practically completed, although the front has not yet been wholly closed in by the seromuscular stitch. The clamp has been loosened but not removed (Munro). The edges of the mesocolic opening have been sewed to the stomach with interrupted stitches.

recommended by Munro,[1] to prevent the anastomosis from sagging back into the abdomen (Fig. 167). After loosening the clamps, it may be found that the bleeding has not been entirely controlled by the through-and-through suture, in which case this opportunity is taken to make the wound perfectly dry before going on. The suture line should now be cleaned

[1] Quoted by Scudder. Annals of Surgery, September, 1904.

before finishing the second line of stitches. This is best done by gentle washing with sterile salt solution. Gauze should not be used for this purpose on account of its abrading effect upon the peritoneum, with its dangers of subsequent adhesions. After washing the suture line, the towel which walls off the operative field is removed, thus exposing the clean gauze beneath. The front is finally closed in with a seromuscular stitch, starting from the long end left on the first outside stitch. Hadra[1] advises suspension of the loop to the stomach, on either side of the anastomosis, to prevent kink formation at this point.

The stomach, transverse colon, and the omentum, which have been replaced within the abdomen, are now withdrawn, and the edges of the mesocolic opening are fastened to the posterior gastric wall, around the anastomosis, with two or three interrupted stitches. This prevents hernia of the small intestine into the lesser peritoneal cavity. When a long proximal jejunal coil is used, it is wise to add a jejunojejunostomy between the proximal and the distal coils in order to eliminate, as far as possible, the danger of circular vomiting. Under these circumstances the gastric anastomosis must be at least ten inches distal to the beginning of the jejunum, in order to allow sufficient room for the lateral intestinal suture to be done without running the danger of leakage from the subsequent tension on the stitches. Fig. 168 shows a cross section explanatory both of the posterior and of the anterior gastroenterostomies.

In his discussion of the relative merits of the anterior and the posterior methods of gastroenterostomy W. J. Mayo[2] speaks as follows:

"For benign disease the posterior operation is the one of choice. It is applied at a higher point on the jejunum, and is unattended with the risk pertaining to the loop which must surround the transverse colon. That this loop is of dangerous import is shown by two of our secondary operations, in one of which a number of feet of small intestine travelled through the noose, and, in the second, death was directly traced to adhesion and obstruction of the transverse colon. The length of this loop is from sixteen to twenty inches, a disadvantage when one considers the proportionately high value of the upper jejunum in digestion and absorption. The anterior

[1] Hadra. Berl. Klin. Wochenschr., 1892, No. 4, p. 75.
[2] Mayo. *Loc. cit.*

operation has some few indications. In cancer the disturbance is less, and, as the gastric juice has little acid, the patient cannot be expected to live long enough to develop a secondary jejunal ulcer. The anterior

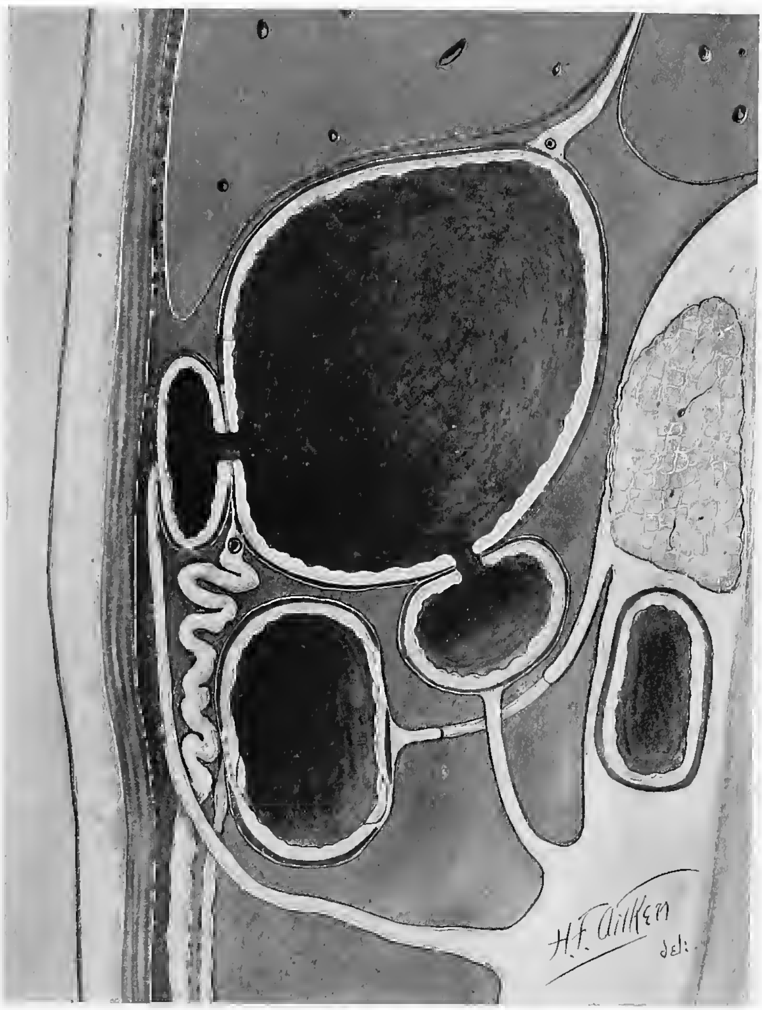

FIG. 168.—GASTROENTEROSTOMY. CROSS SECTION.

Two coils attached to show anterior and posterior methods. The section of the anterior gastro-enterostomy has been made at the point where the great omentum passes off to the side of the mesentery of the jejunum.

operation is more liable to be followed by contraction on account of the traction weight of the attached jejunum, a diverticulum formation taking place which is followed later by contraction. This happens most fre-

quently after the button, as the line of union is narrow and it has less of a grasp on the tissues. Contraction, however, is liable to occur after any form of operation, especially if the pylorus is unobstructed. With an open pylorus nature tends to close the opening, no matter what the form of operation; but the shorter the loop the less the probability of contraction, and in the operations without a loop we would not consider it a serious question. We have seen a reduction of one-half take place three and five months, respectively, after a Moynihan operation on a nine-inch loop."

In "Annals of Surgery" for April, 1906, W. J. Mayo describes a modification of the method of attaching the jejunum to the posterior wall of the stomach. The gastric incision begins at a point one inch above the greater curvature, on a continuation of a line passing through the vertical portion of the lesser curvature. The incision ends at the bottom of the stomach, two and a half inches to the left. The stomach clamps are placed with handles to the right, their tips holding the lowest point of the stomach, including a bit of the greater curvature itself. The jejunum is clamped from one and a half to three and a half inches from its origin, the distal portion of the clamped folds being placed in the tips of the clamps. In this technic the jejunum is not reversed, thus avoiding the kink which is formed in the jejunum when Moynihan's technic is employed. Mayo states that, although the peristaltic waves of the stomach and of the jejunum travel in different directions, this fact has apparently made no difference to his results, which have been excellent. The technic for the lateral anastomosis is not changed.

ANTERIOR GASTROENTEROSTOMY.

(Wölfler.[1])

The anterior gastroenterostomy is not at present considered to be the operation of choice, but it is indicated when the posterior operation is impossible. To quote Robson[2]: "In cases of extensive adhesions, involvement of the posterior wall of the stomach in the disease, a form of congenital deformity in the shape of a very short mesocolon, the posterior gastroenterostomy may be impracticable."

[1] Wölfler. Cent. für Chir., 1881, No. 15; 1883, No. 23.
[2] Robson. *Loc. cit.*

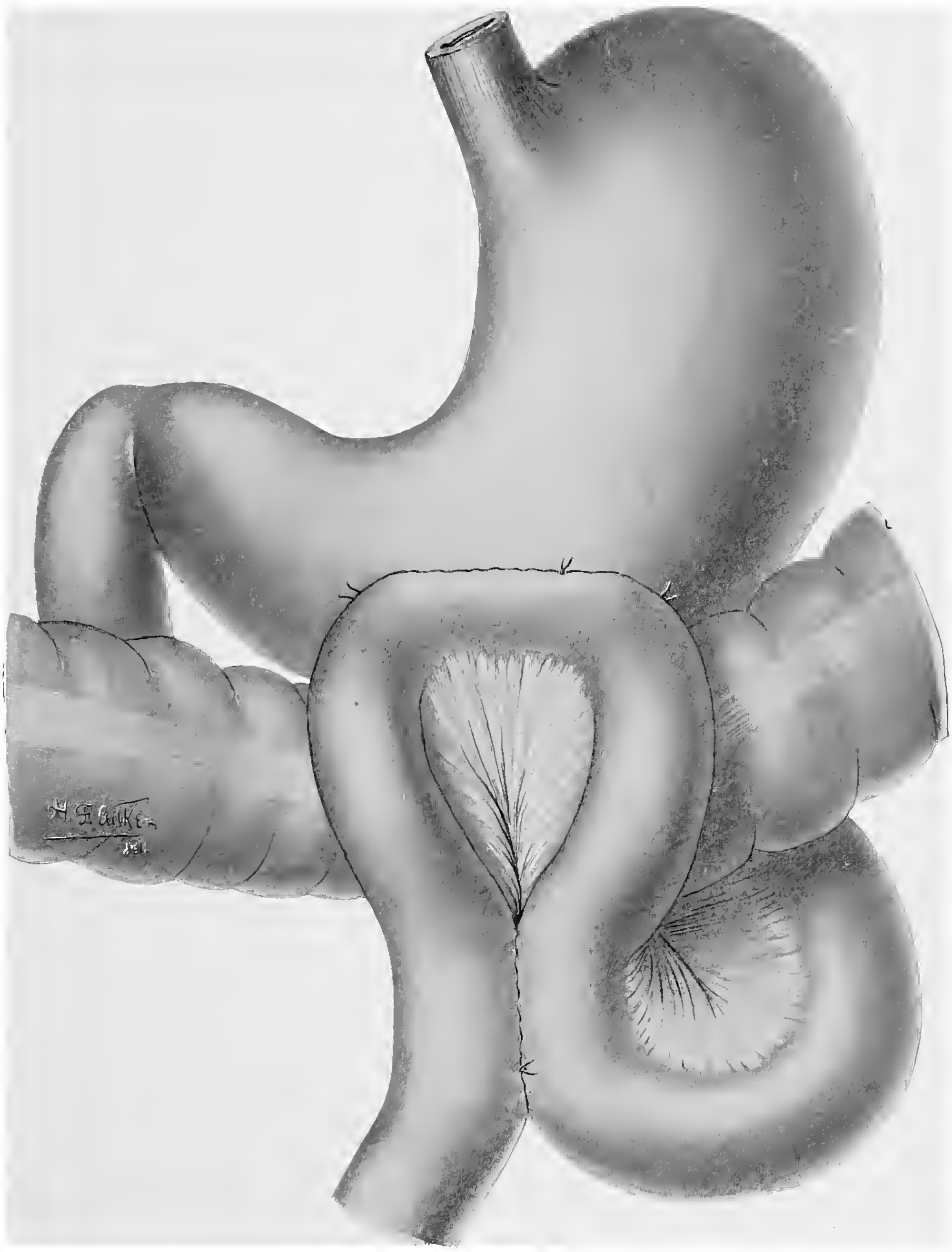

FIG. 169.—DIAGRAM, ANTERIOR GASTROENTEROSTOMY.
Jejunojejunostomy between proximal and distal coils.

Steps:

(1) Abdomen opened; stomach exposed.

(2) Duodenojejunal flexure identified.

(3) Gastrojejunostomy on anterior wall of stomach.

(4) Jejunojejunostomy between afferent and efferent loops.

The abdomen is opened, the stomach turned up as if for a posterior gastro-enterostomy, and the beginning of the jejunum identified. The stomach is then turned back into its natural position, with its anterior wall forward, and about sixteen inches of the jejunum drawn out in front of the great omentum and the transverse colon. The anastomosis between the stomach and the jejunum is done at this point, after Wölfler's method, placing the stoma at the lowest point on the anterior wall, parallel to the greater curvature. After completing the anastomosis, a stay stitch may be placed at either angle of the suture (Hadra[1]) to prevent the coils from dragging down and creating a kink at the opening. It is felt, by a large number of surgeons, that circular vomiting is less likely to occur if a jejunojejunostomy is added between the proximal and the distal coils. The place for this second anastomosis is about four or five inches below the gastroenterostomy. It can be done by plain suture, or by mechanical devices, as desired (Fig. 169).

PYLORECTOMY.

This operation consists in the excision of the pyloric portion of the stomach. The size of the area removed depends, partly, upon the extent of involvement of the stomach; but the conception of the modern technic is based almost wholly upon the direction of the lymphatic currents in the gastric walls, and upon the sequence of infection of the adjoining lymphatic glands. The operation derives its importance from the fact that from 60 to 70 per cent. of all gastric cancers originate at or near the pylorus. Before describing the operation in detail, a short review of the blood and the lymph supply of the stomach will be given.

The Blood Supply of the Stomach[2] is derived from the celiac axis, which is made up of three trunks: the gastric, the hepatic, and the splenic arteries.

[1] Hadra. *Loc. cit.*

[2] Gray's Anatomy.

The Gastric Artery is directed upward to the left, where it joins the stomach near the cardiac orifice, distributing branches to the esophagus, which anastomose with the aortic esophageal arteries. Other branches supply the cardiac end of the stomach, inosculating with branches of the splenic artery. The gastric artery then passes down on the lesser curvature, from left to right, to the pylorus, lying, in its course, between the layers of the lesser omentum, and giving branches to both surfaces of the organ. At its termination the gastric anastomoses with the pyloric branch of the hepatic.

The Hepatic Artery supplies the stomach with two vessels: the pyloric, and the gastroduodenalis.

The Pyloric Artery arises from the hepatic, above the pylorus. It passes down to the pyloric end of the stomach, and travels from right to left along the lesser curvature, supplying it with branches, and inosculating with the gastric artery.

The Gastroduodenalis Artery is a short but large branch which descends behind the first portion of the duodenum to the lower border of the stomach where it gives off a large branch, the gastroepiploica dextra, to the greater curvature.

The Gastroepiploica Dextra Artery passes from right to left along the greater curvature of the stomach between the layers of the great omentum, anastomosing about the middle of the lower border of the stomach with the gastroepiploica sinistra of the splenic artery. It gives off numerous branches, some of which ascend to supply both surfaces of the stomach, while others descend to supply the great omentum.

The Splenic Artery contributes two sets of vessels to the blood supply of the stomach: the vasa brevia, and the gastroepiploica sinistra.

The Vasa Brevia consist of from five to seven small branches which arise either from the termination of the splenic artery or from its terminal branches. They pass from left to right between the layers of the gastro-splenic omentum and are distributed to the greater curvature of the stomach, anastomosing with branches of the gastric and gastroepiploica sinistra arteries.

The Gastroepiploica Sinistra Artery, the largest branch of the splenic, runs from left to right along the greater curvature of the stomach, between

FIG. 170.—THE BLOOD SUPPLY OF THE STOMACH.

Note the celiac axis, consisting of the gastric, the splenic, and the hepatic arteries. The gastroduodenalis artery appears faintly through the pyloric portion of the stomach. Note also the portal system and the bile ducts.

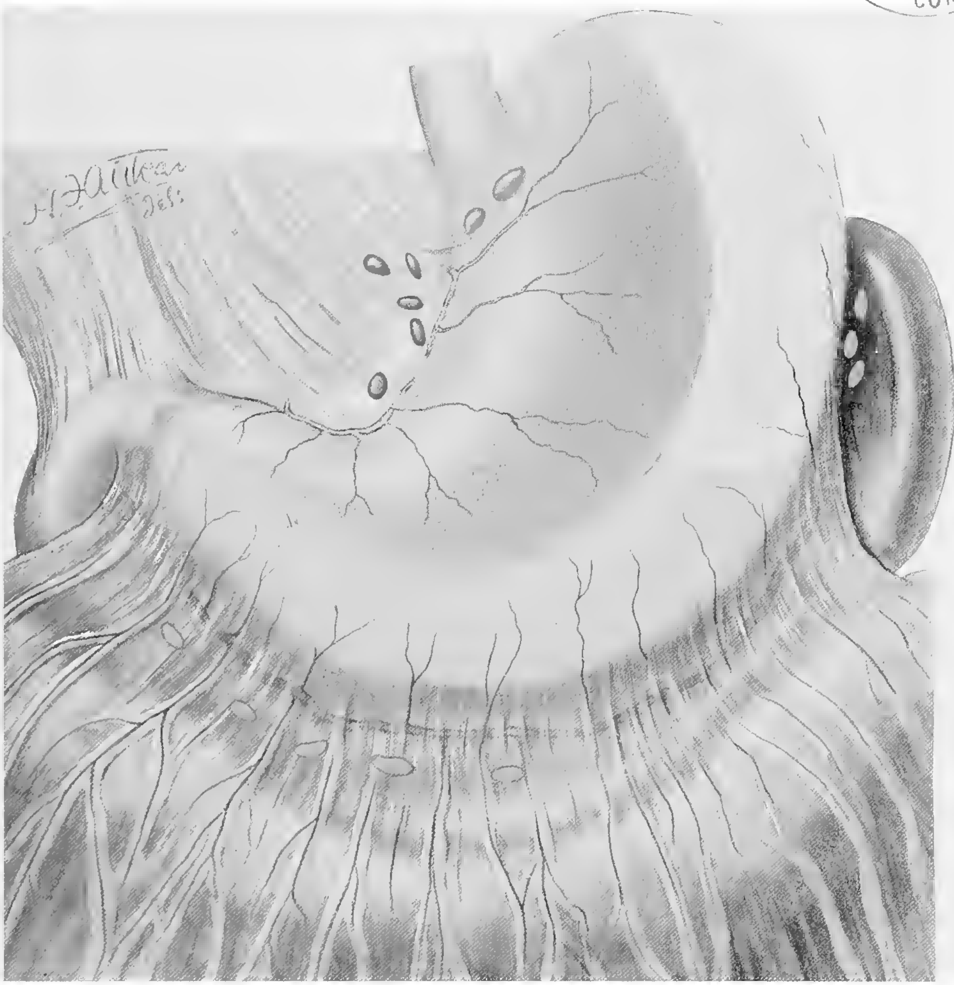

FIG. 171.—THE LYMPHATIC DRAINAGE OF THE STOMACH, TO ILLUSTRATE CUNÉO'S DIVISION INTO TERRITORIES.

Glandular groups have the same colors as the areas drained by them.

Pink: Coronary area, coronary group of glands on the lesser curvature.

Yellow: Lower portion of pyloric zone, subpyloric group of glands, about gastroepiploica dextra artery.

Blue: Fundus, splenic chain of glands.

Yellow-shaded: retropyloric group of glands. The coloring stops at the pyloric sphincter to show the position of the retropyloric group, which are drawn in at the correct level.

the layers of the great omentum, and anastomoses with the gastroepiploica dextra. In its course it distributes several branches to the stomach which ascend upon both surfaces; others descend to supply the great omentum (Fig. 170).

The Lymph Supply of the Stomach.—The lymphatic drainage of the stomach has been thoroughly studied by Cunéo,[1] and the author is indebted to this investigator for the facts given below (Fig. 171).

The gastric walls are supplied with two sets of lymphatics, the one draining the mucous layer, the other the muscular layer. The two sets of lymphatics supplying a given area empty into the same glandular chain. The general direction of the lymphatic stream is toward the right, except at the fundus, where it travels toward the left. Each lymphatic stream empties into a definitely placed group of glands ("first relay"), after which all currents converge and join at the preaortic glandular group, placed about the celiac axis ("second relay"). Conversely, each glandular group drains a definite portion of the stomach walls, and, for this reason, Cunéo has named these lymphatic territories after the glandular chains with which they are connected. The main glandular chains are situated, respectively, about the coronary artery and its branches, the hepatic artery and its branches, and the splenic artery and its branches.

The coronary or gastric chain of glands receives the lymph from the two-thirds of the stomach adjoining the lesser curvature. It is comprised of from two to six glands which are placed along the course of the gastric artery and its principal branches. In the region of the cardia, a small mass of glands is found on the ascending branch of the coronary artery which is in communication with the esophageal lymphatics. In the region of the pylorus, the coronary stream takes the lymph from the upper half of the stomach to the glands on the lesser curvature, while the lower half drains into the glands on the right gastroepiploic artery.

The splenic chain of glands is distributed along the course of the splenic artery to its termination in the hilum of the spleen. It is comprised of from four to ten glands which receive the lymph from the area supplied by the vasa brevia, and the gastroepiploica sinistra (fundus).

The hepatic chain of glands receives its main supply from the liver.

[1] Poirier, Delamere, and Cunéo. "The Lymphatics," 1903.

It also receives the lymph which travels along the secondary chain about the right gastroepiploic artery. The right gastroepiploic chain is comprised of two distinct glandular groups, the subpyloric, and the retropyloric.

The subpyloric chain averages from three to six glands, which are situated between the layers of the great omentum, beneath the pyloric zone of the stomach. These glands are but rarely found in the middle part of the greater curvature, and very rarely in the region of the fundus. This group is usually placed at a distance from the greater curvature, along the descending branches of the gastroepiploic arch, and may be left in situ, during pylorectomy, unless their increase in size renders them apparent. The subpyloric glands receive the lymph from the inferior part of the pyloric portion of the stomach and from the upper part of the greater omentum. Their efferent vessels usually terminate in the retropyloric group; but frequently go to the glands about the superior mesenteric vessels.

The retropyloric chain is placed along the gastroduodenal artery, in continuity with the subpyloric below and the main hepatic chains above. It is comprised of two or three glands which are in relation with the pylorus in front, and with the pancreas behind. This group is not uncommonly absent, and, when present, was found by Cunéo to have been always infected. They receive the lymph from the subpyloric group, and also from the posterior surface of the pylorus, and from the first part of the duodenum. Sappey[1] has demonstrated that there is a communication between the lymphatics of the stomach and those of the duodenum, although neither Most[2] nor Cunéo[3] have been able to corroborate his work. There is little doubt that there is a connection between the duodenum and the stomach, as the duodenal glands have been injected through the mucosa of the stomach; but the connecting lymphatics do not show a high grade of development. The three cardinal facts upon which the technic of pylorectomy is founded are the following:

1. The slight lymphatic communication between the duodenum and the stomach impedes the advance of the infection into the intestine.

[1] Sappey. Traité d'Anat. Physiologique et Pathologique des vaisseaux lymphatiques, 1874, p. 76, and following, pl. xxv, Fig. 1.

[2] Most. Arch. f. Klin. Chir., LIX, 1, p. 175.

[3] Cunéo. Thèse, Paris, 1900, and Cunéo et Delamere, Journal de l'Anat. et de la Physiologie, 1900.

2. Metastases from pyloric cancer first invade the glands on the lesser curvature, and on the subpyloric part of the greater curvature.

3. The dome of the stomach is practically isolated from lymphatic infection by pyloric cancer.

It will be noted, therefore, in performing the operation, that,—

1. The duodenum is spared up to within three centimeters of the pylorus.

2. The whole lesser curvature, with its glands, is removed up to within two and one-half centimeters of the cardia, together with the subpyloric part of the gastrocolic omentum.

3. The dome of the stomach and a good share of the greater curvature are saved, following the Hartmann-Mikulicz line of section.

In a recent article W. J. Mayo[1] has collected and simplified the technical improvements described by Czerny, Kocher, Hartmann, Mikulicz, and others. The result is a composite operation of great value. In the following description the author has followed rather closely the procedure advised by Mayo:

Steps:

(1) Exploratory abdominal incision.
(2) Gastric artery divided between two ligatures.
(3) Lesser omentum double tied and resected close up to liver.
(4) Pyloric artery divided between two ligatures, and upper end of duodenum freed.
(5) Ligation of gastroduodenal, or of right gastroepiploic artery.
(6) Gastrocolic omentum resected in sections close to transverse colon, from right to left, as far as is necessary.
(7) Ligation of left gastroepiploic artery.
(8) Duodenum double clamped and resected, open end closed.
(9) Stomach double clamped and resected, proximal to growth, open end closed.
(10) Gastrojejunostomy.

The abdomen is entered through a short median incision, half way between the ensiform cartilage and the umbilicus. Through this opening a careful digital exploration is made to determine the operability of the growth. If the condition is found to be inoperable, Mayo closes the abdominal

[1] Mayo, W. J. Annals of Surgery, March, 1904.

FIG. 172.—RELATIONS AROUND THE HEAD OF THE PANCREAS.
Note the close relation of the gastroduodenal artery to the head of the pancreas.

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incision with insoluble mattress sutures of silk, linen, or wire, placed in the aponeurosis of the linea alba. Sutures of this description will allow the patient to get about in a few days, and thus avoid the general debility, and hypostatic pulmonary lesions, which rapidly supervene when advanced malignant cases remain in bed for the length of time necessary for the wound to heal completely. If the condition is operable, the incision is enlarged to four or five inches, and the stomach exposed.

As seen in Fig. 170, the pyloric portion of the stomach is supplied by four arteries: the gastric and the pyloric on the lesser, and the right and the left gastroepiploics on the greater curvatures. If these four vessels are tied at once, the remainder of the operation will be practically bloodless. The gastric artery is tied double and cut at the point where it reaches the lesser curvature, about two and one-half centimeters below the cardiac orifice. The lesser omentum is next tied double and cut in sections, close up to the liver, from left to right, from the point where the gastric artery has been tied up to the three large structures placed at the right border of the omentum (*i. e.*, hepatic artery, common duct, and portal vein). In early cases of cancer a free excision of the lesser omentum is carried out in the same manner, since the omental fat may be already infected, before glandular enlargement is discernible. The pyloric artery is then double tied and divided near the pylorus, and the first part of the duodenum freed for three or four centimeters, to facilitate its resection later. Fig. 172 shows the relation of the vessels around the head of the pancreas. The ligature of the gastrohepatic omentum mobilizes the pyloric end of the stomach with the tumor (Fig. 173), so that, by introducing the fingers behind the pylorus, the gastroduodenal, or the right gastroepiploic arteries can easily be reached. It will be remembered that the retropyloric glands lie in the groove between the duodenum and the head of the pancreas, and receive the lymph from the subpyloric group in the gastrocolic omentum. These retropyloric glands must always be removed, if found enlarged; but, as they surround the gastroduodenal artery, this vessel must be tied above the glands before trying to dissect them out (Kocher). If these glands are not enlarged, the

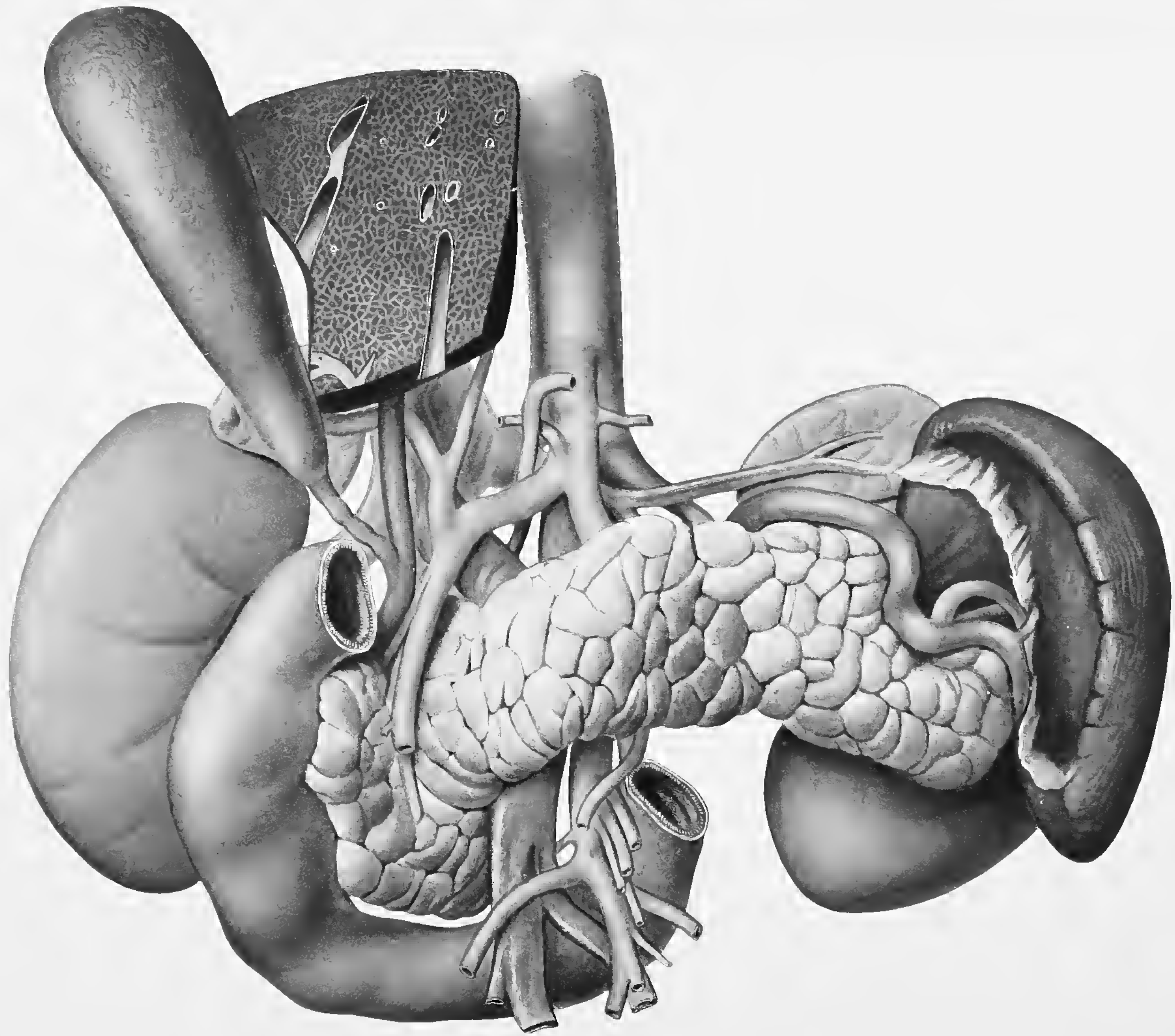

Fig. 172

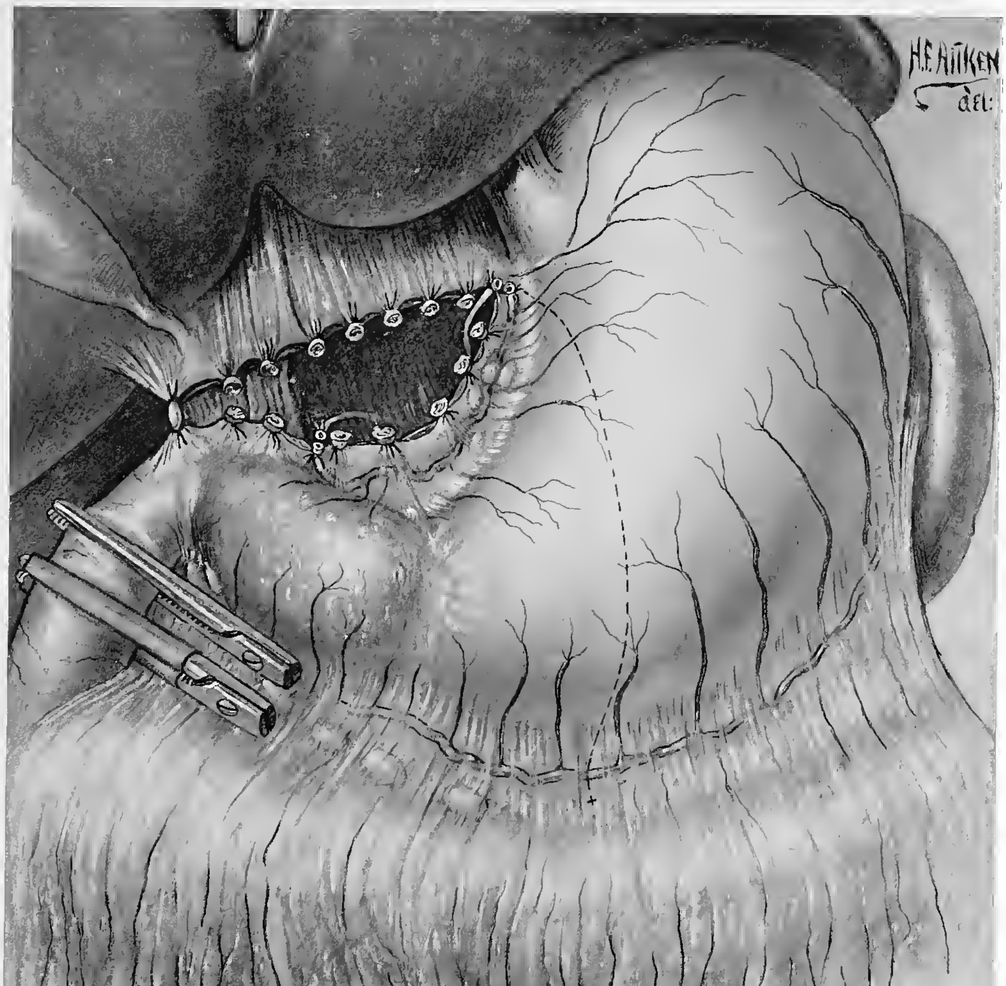

FIG. 173.—PYLORECTOMY.

Gastric and pyloric arteries tied and cut. Section of the lesser omentum, saving the bile duct and blood-vessels at the edge of the omentum. Clamps on duodenum at the level of future section. The Hartmann-Mikulicz line of section. (This series is redrawn from W. J. Mayo's technic.)

FIG. 174.—PYLORECTOMY.

Section of duodenum between clamps, distal end partly closed in. Ligature of gastroduodenalis and of gastroepiploica sinistra arteries. Section of gastrocolic omentum close to transverse colon. Kocher's clamps on stomach at the Hartmann-Mikulicz line of section.

fingers behind the pylorus separate the gastrocolic omentum from the transverse mesocolon, and the ligature placed farther down on the right gastroepiploic artery. The gastrocolic omentum is next resected in sections from right to left for the desired distance on the greater curvature (Fig. 174). The subpyloric glands are situated at a distance from the greater curvature, and, to be certain of removing all of the infected tissue, the resection of the gastrocolic omentum must be carried close to the transverse colon. Metastases from disease of the greater curvature are occasionally carried to the glands of the transverse mesocolon. This region should be examined. Sometimes the distal cut edge of the greater omentum becomes much congested from venous obstruction on the right where it extends out over the duodenum. In cases where drainage is employed, Mayo advises excising this devitalized omentum. Care should be exerted, in tying off the gastrocolic omentum, to separate it from the mesocolon in order to avoid including in the ligature the colica media artery. This vessel furnishes practically the whole blood supply to the transverse colon, and its accidental inclusion in a ligature would not be difficult (Lauenstein,[1] Gutsch,[2] Czerny,[3] Küster),[4] owing to the normally close apposition of the mesocolon to the gastrocolic omentum. The left gastroepiploic artery is, finally, tied at a point on the greater curvature selected for the lower extremity of the line of section. Figs. 175 and 176 show the relation of the colica media artery to the gastrocolic omentum. The stomach now being freely movable, and its posterior wall easily accessible, the peritoneal cavity is walled off with gauze and the resection begun. In excising the diseased pyloric portion a difference of opinion exists as to which end should be first cut away, the distal (duodenal), or the proximal (nearest cardia), Kocher[5] preferring the former, and Hartmann[6] the latter. Mayo[7] has found both methods indicated in special cases; but, as a routine, resects the duodenal end first, as it allows a better exposure of the stomach while working

[1] Lauenstein. Cent. für Chir., 1882, No. 7; *ibid.*, 1885, No. 8, 121.

[2] Gutsch. Bericht über den 12 Chirurgen Congress.

[3] Czerny. Wien. Med. Woch., 1884, No. 17, p. 18–19.

[4] Küster. Cent. für Chir., 1884, p. 754.

[5] Kocher. Text-Book of Surgery.

[6] Hartmann. "Chirurgie de l'estomac," Verhandl. des XIII, Internationalen Med. Congresses, Paris, 1900.

[7] Mayo. *Loc. cit.*

FIG. 175.—SOUND INTRODUCED THROUGH THE FORAMEN OF WINSLOW.

Gastrocolic omentum opened to show its close relation to the transverse colon. (Sobotta.)

FIG. 176.—GASTROCOLIC OMENTUM CUT AND STOMACH LIFTED, EXPOSING THE LESSER PERITONEAL CAVITY.

This demonstrates the danger of including the colica media artery when ligating the gastrocolic omentum during a pylorectomy.

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deep under the costal arch. This method is described later. The integrity of the duodenum in cancer of the pylorus has been regarded as established, because of the poor lymphatic communication through the pyloric sphincter. Cunéo[1] found malignant extension into the intestine in 37 per cent. of the cases which he examined, and Borrmann[2] in 32 per cent. In these cases the duodenum frequently appeared, macroscopically, to be intact, when it had been already invaded. Cunéo considers that the first two centimeters of the duodenum should be regarded as a suspicious zone, and that resection should be made at least three to four centimeters from the sphincter. Two small clamps are applied to the duodenum at a safe margin from the extreme edge of the growth (Furguson[3]), and the intestine divided between them, either with a cautery (Mayo) or with a knife. The cautery is used to prevent the accidental inoculation of the cut edges with cancer and to stop hemorrhage at once. The closure of the duodenal stump is done by sewing the cut edges together with a glover's stitch. The edges are then invaginated and held in place by a purse-string suture exactly as described earlier, and shown in Figs. 111, 112 and 113.

In determining the proximal line of section, the method of lateral progression of the growth must be borne in mind. Czerny[4] originally advocated allowing a margin of only one centimeter from the apparent edge of the growth. Eiselsberg[5] and Mikulicz[6] find it necessary to remove "several centimeters," without stating explicitly how many. Cunéo[7] has shown that the appearance of the serous surface of the stomach may give no clue to

[1] Cunéo. Thèse de Paris, 1900, G. Steinthal; Revue de Chirurgie, 1900, p. 1513.

[2] Borrmann. Mitth. aus den Grenzgeb., I. Supplbd., 1901; "Das Wachsthum und die Vorbreitungwege der Magenscarcinoms," Iéna, C. Fischer, 1901.

[3] Quoted by Mayo. Jour. Amer. Med. Asso., April 7, 1906.

[4] Czerny. Quoted by Guinard in his thesis at Paris: "La cure chirurgicale du cancer de l'estomac," 1898, p. 125.

[5] Eiselsberg. *Ibid.*

[6] Mikulicz. Arch. f. Klin. Chir., Bd. LVII, 1898, p. 527.

[7] Cunéo. Thèse, p. 41, and Soc. Anat. communic. de Juillet, 1900 (en collaboration avec Lecène).

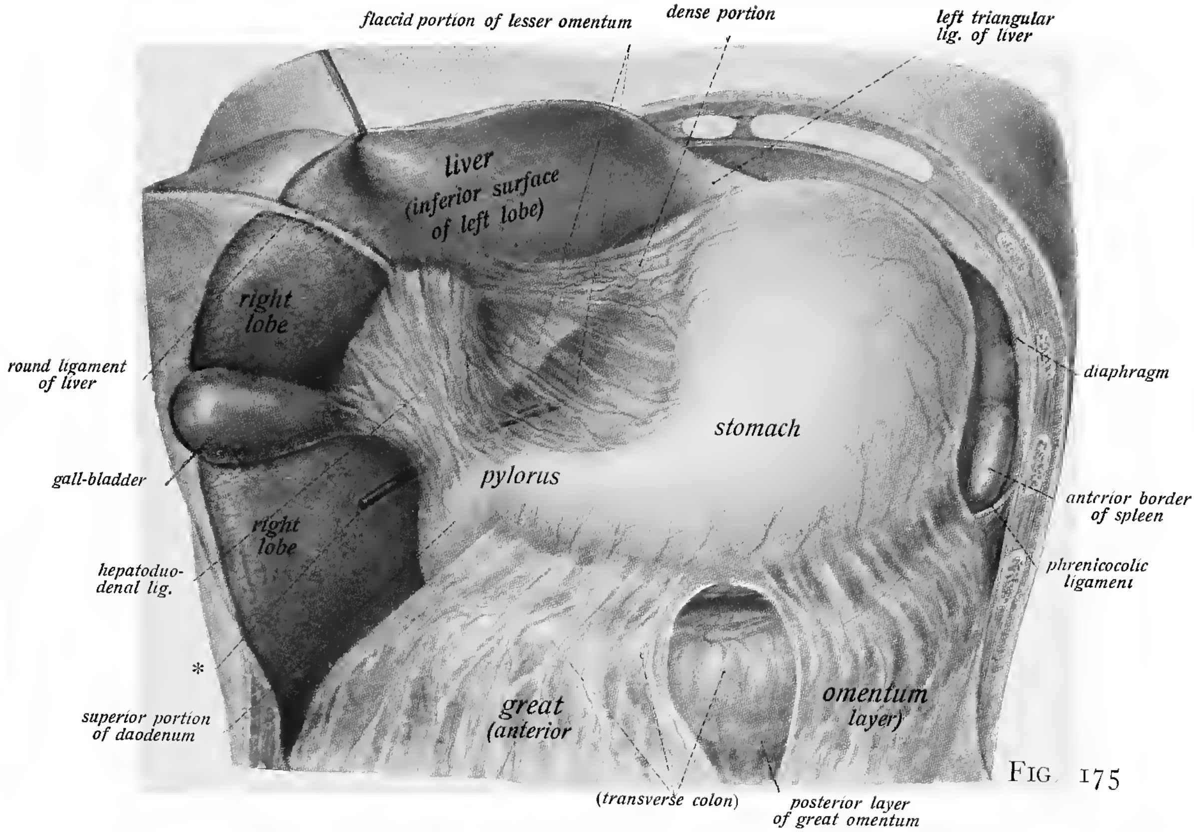

FIG. 175

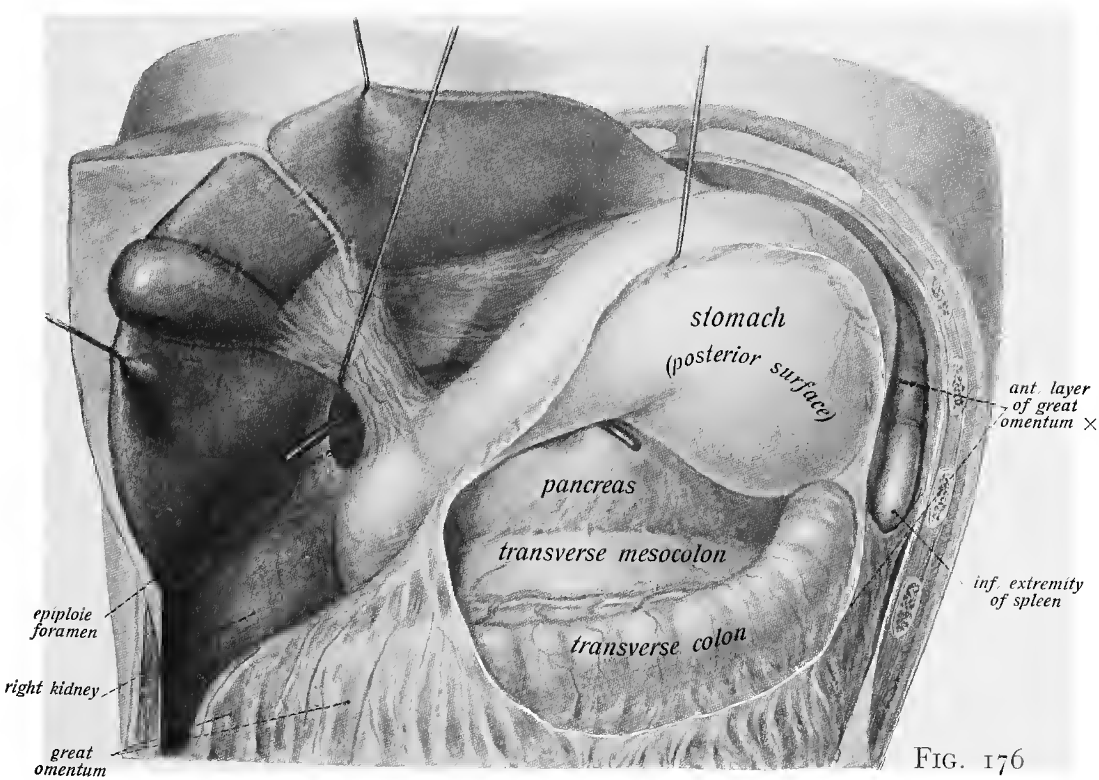

FIG. 176

the surgeon whether or not the underlying stomach wall is sound, because growth spreads most rapidly through the submucous layer (Fig. 177). The serous layer is not involved until the muscular has been penetrated, where resistance to the advance of the growth is well known. Czerny has since proposed leaving a margin of three centimeters from the apparent edge of the growth, and this has been adopted by Carle and Fantino[1] and by Hartmann.[2] Cunéo feels that this represents the minimum edge that should be left, and urges taking more leeway, as a rule.

To recapitulate: The lesser curvature receives the bulk of the lymphatic supply from both walls of the stomach. In early cases the omental fat may be infected when few or no glands may be found enlarged. For this reason the whole lesser curvature and the lesser omentum are to be removed in every case. Mikulicz's point of election is two and one-half centimeters below the cardiac orifice, just where the gastric artery is tied. Since the direction of the lymphatic stream is toward the right, on the greater curvature, following the right gastroepiploic artery, malignant extension to the left will be less rapid here in proportion to that on the lesser curvature. On this account it will be found that a good portion of the greater curvature can be saved, and, if a point on this curvature at least three centimeters from the growth be chosen, Hartmann's point of election will be established. By connecting the points chosen on the two curvatures, a line of section results which passes across the stomach obliquely downward and to the right. Every point of this line must be at least three centimeters from the extreme apparent edge of the growth.

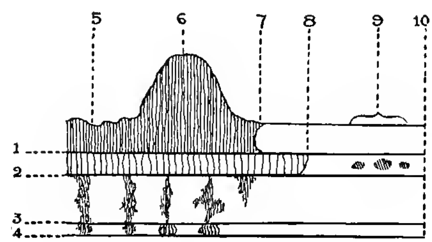

FIG. 177.—PYLORECTOMY.

Shows manner of extension of growth (from Hartmann and Cunéo). 1. Mucosa; 2, submucosa; 3, muscularis; 4, serosa; 5, floor of malignant ulcer; 6, edge of ulcer; 7, lateral limit of extension of growth in mucosa; 8, lateral limit of extension of growth in submucosa; 9, metastatic nodules in submucosa; 10, safe margin for resection of stomach wall.

A long Kocher clamp is placed obliquely across the stomach, between the two points mentioned above, while a second rubber-

[1] Carle and Fantino. Arch. f. Klin. Chir., Bd. LVI, 1898, H. 1 and 2, p. 226.

[2] Hartmann. "Chirurgie Gastro-intestinale," Paris, 1901.

covered clamp is applied about one inch proximal to the first clamp and parallel with it. The resection is made between the two clamps along the Hartmann-Mikulicz line, either with a cautery, or with scissors, leaving an edge of at least half an inch projecting through the proximal clamp. When scissors are employed for resecting the stomach the two walls should be cut away separately, directly through all coats, the mucous membrane being trimmed down later flush with the muscular coats. It is possible to cut the muscular and the mucous coats at the same time in such

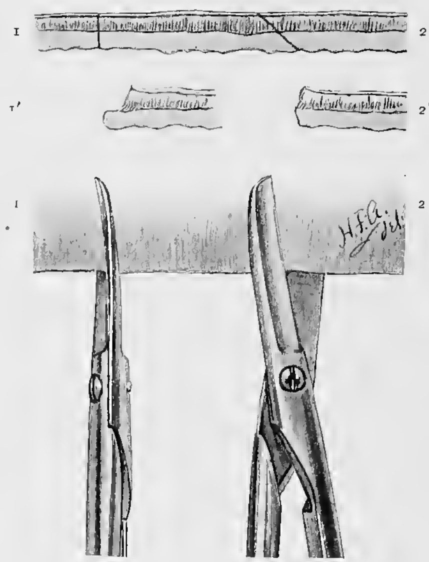

FIG. 178.—PYLORECTOMY.

The lower figure shows the method of holding the scissors. The upper figure shows the line in which the scissors cut, when held in the position shown in the corresponding figure below. 1' and 2' show the resulting cut edges, after holding the scissors as in 1 and 2. When held straight as in 1, the mucous membrane projects beyond the muscle coats; when held on the oblique as in 2, the mucous membrane is trimmed flush.

a way that it will leave the two coats flush, without further trimming. This is done by pressing the inside blade of the scissors close to the mucous membrane on the clamp side, and thus bevelling the mucous membrane as the scissors cut (Fig. 178). After the resection is completed, the cut edges tend to retract through the proximal clamp at the two extremities of the wound. A snap placed on either end will prevent this while the first layer of sutures is being introduced. The cut edges are sewed together in the usual manner, with two layers of stitches, an inner through-and-though,

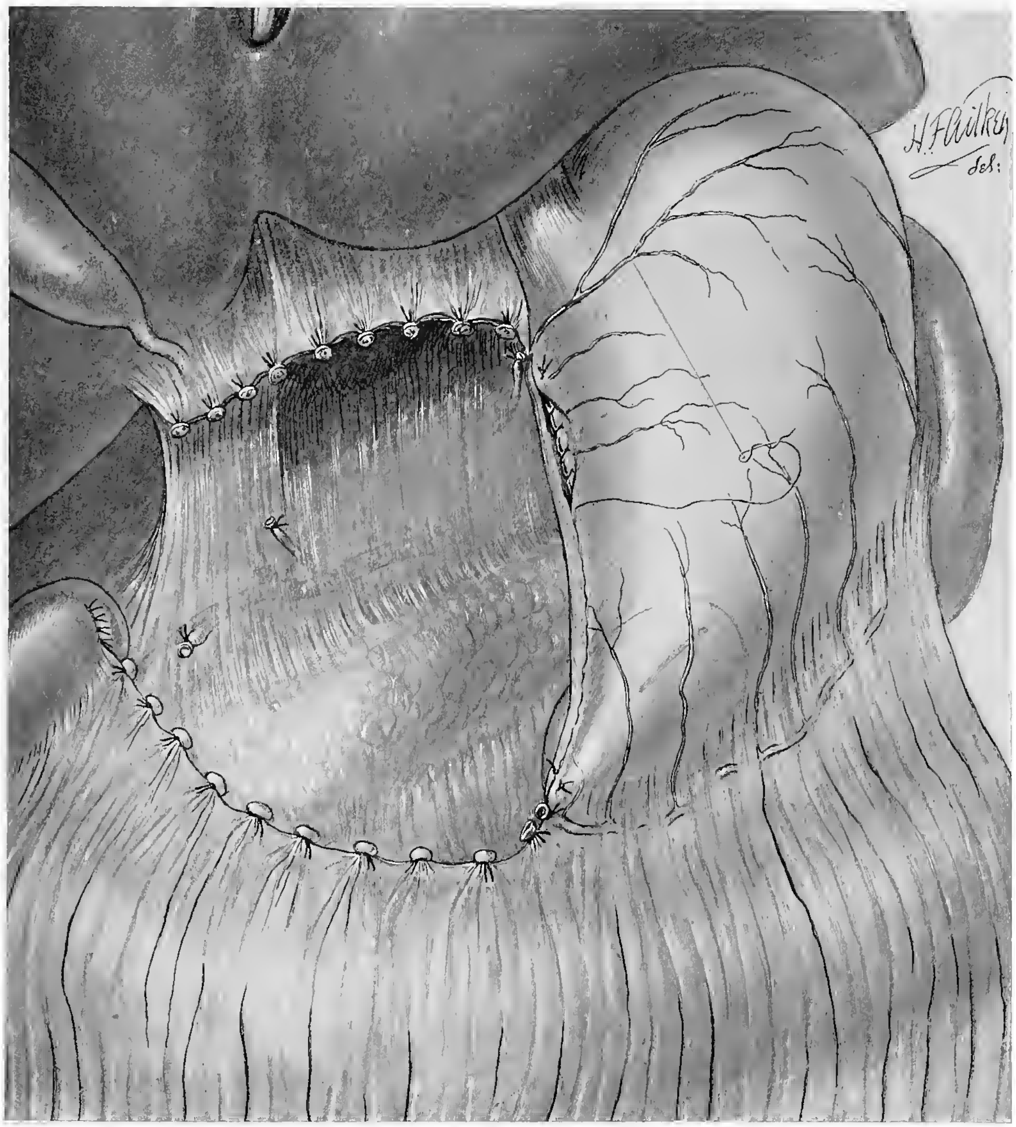

FIG. 179.—PYLORECTOMY.

The distal end of the duodenum is now wholly closed in. Note tied gastric, pyloric, gastroduodenalis, and gastroepiploica sinistra arteries. Stomach practically closed in. Posterior gastroen terostomy.

and an outer seromuscular. Both sutures may be continuous. After the introduction of the inner layer the clamp is taken off and any bleeding points tied at once (Fig. 179). Before carrying the seromuscular stitch across the stump, it will be found of advantage to close in the two projecting ends. For this purpose two interrupted stitches, such as the author's mattress, are used.

The last step in the operation consists in again connecting the intestinal tract with the stomach. Three methods are in use to accomplish this anastomosis: 1. By joining the distal open end of the resected duodenum to the open end of the stomach, after reducing the caliber of the gastric opening to that of the intestine (Billroth[1]). This technic is being generally abandoned because of the great danger of leakage, although it is still giving good results to Conant[2], and others. 2. By anastomosing the cut duodenal end to the stomach at a sound spot on its posterior wall, after wholly closing the open end of the stomach (Kocher[3]). 3. The technic which gives the best results, and which was also suggested by Billroth, namely, a gastro-jejunostomy, preferably on the posterior wall, after closing the open-ends, both of the stomach and the duodenum.[4]

Drainage is not usually necessary, but when sepsis is feared a cigarette-wick should be placed at the lower angle of the wound, reaching down to a point just above the transverse colon (Mayo[5]).

PARTIAL GASTRECTOMY.

This operation (resection of the middle portion of the stomach) is done for disease of the body of the stomach, such as stricture, or for malignant disease. The technic is merely an application of the usual methods for lateral anastomosis.

Steps:

(1) Ligature of vesels on the greater and the lesser curvatures.

(2) Double ligature of omenta in section; resection between ligatures.

[1] Billroth. I. Wien. Med. Wochenschr., 1881, No. 6, S. 162.

[2] Conant. Unpublished technic.

[3] Kocher. Archiv für Klin. Chir., 1891, Bd. XLII, S. 542.

[4] Billroth. II. Reported by von Hacker, Die Verhandl. der Deutsch. Gesellsch. für Chir., 1885, Part II, Vol. XIV, p. 62.

[5] Mayo. *Loc. cit.*

(3) Clamps.

(4) Resection of the stomach.

(5) End-to-end anastomosis.

The stomach is withdrawn from the abdomen, and the causes of the condition investigated. The transverse mesocolon should be specially examined since its glands receive lymph from the stomach. This operation is usually performed for malignant disease, and a discovery of glands in one of the pathognomonic situations will give a clue to the extent and the site of the lesion. The ligature of the vessels on the curvatures is simpler than is the case in the pylorectomy, because the arteries are all tied at more easily accessible points. On the lesser curvature the descending branch of the gastric artery is tied double and cut on each side of the area to be resected, but leaving enough of the vessel to be sure of a good supply for the sutured edges. On the greater curvature, the epiploic arteries are tied in the same manner as was the gastric, on each side of the area to be cut out. If a suspicion of malignancy exists, a good-sized V must be excised, both from the greater and from the lesser omenta. The V of greater omentum must include the subpyloric glands close to the transverse colon, while in the lesser omentum all glands and doubtful tissue are taken out. This operation, in other words, must conform with Hartmann and Cunéo's rules for pylorectomy (Fig. 180). After the omenta have been ligated, in sections, walling-off gauze is slipped beneath the stomach to protect the lesser peritoneal cavity from infection. The stomach is now double-clamped on either side of the area to be removed. The clamps are placed about one inch apart, allowing from one and one-half to two inches margin of healthy tissue. Harrington's straight clamps were designed for this operation. The resection is best done with scissors, in the method adopted for the pylorectomy, wiping away the mucus and contents which leak out as the incision is made. After the diseased portion of the stomach has been taken away and the edges of the gastric walls, projecting through the clamps, wiped clean, a fresh slip of gauze is substituted, to wall off the lesser peritoneal cavity, and the two clamps are brought side by side. There are several methods of anastomosing the stomach end to end. Scudder[1] has successfully applied

[1] Scudder. Annals of Surgery, 1905, Vol. 41, p. 712.

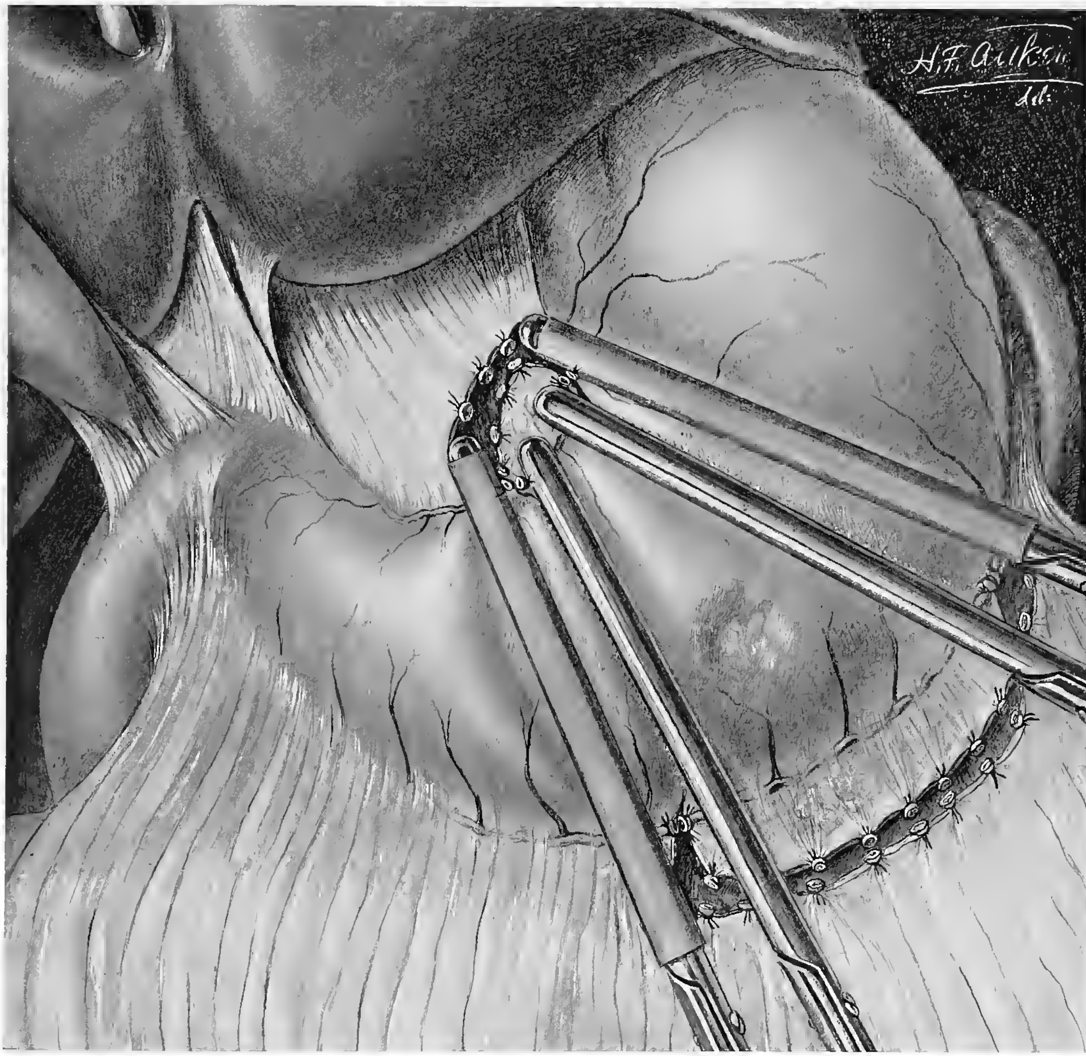

FIG. 180.—RESECTION OF THE MIDDLE PORTION OF THE STOMACH.

Harrington's straight clamps in position. Incisions have been made into both mesenteries. Section lines on stomach indicated by dotted lines.

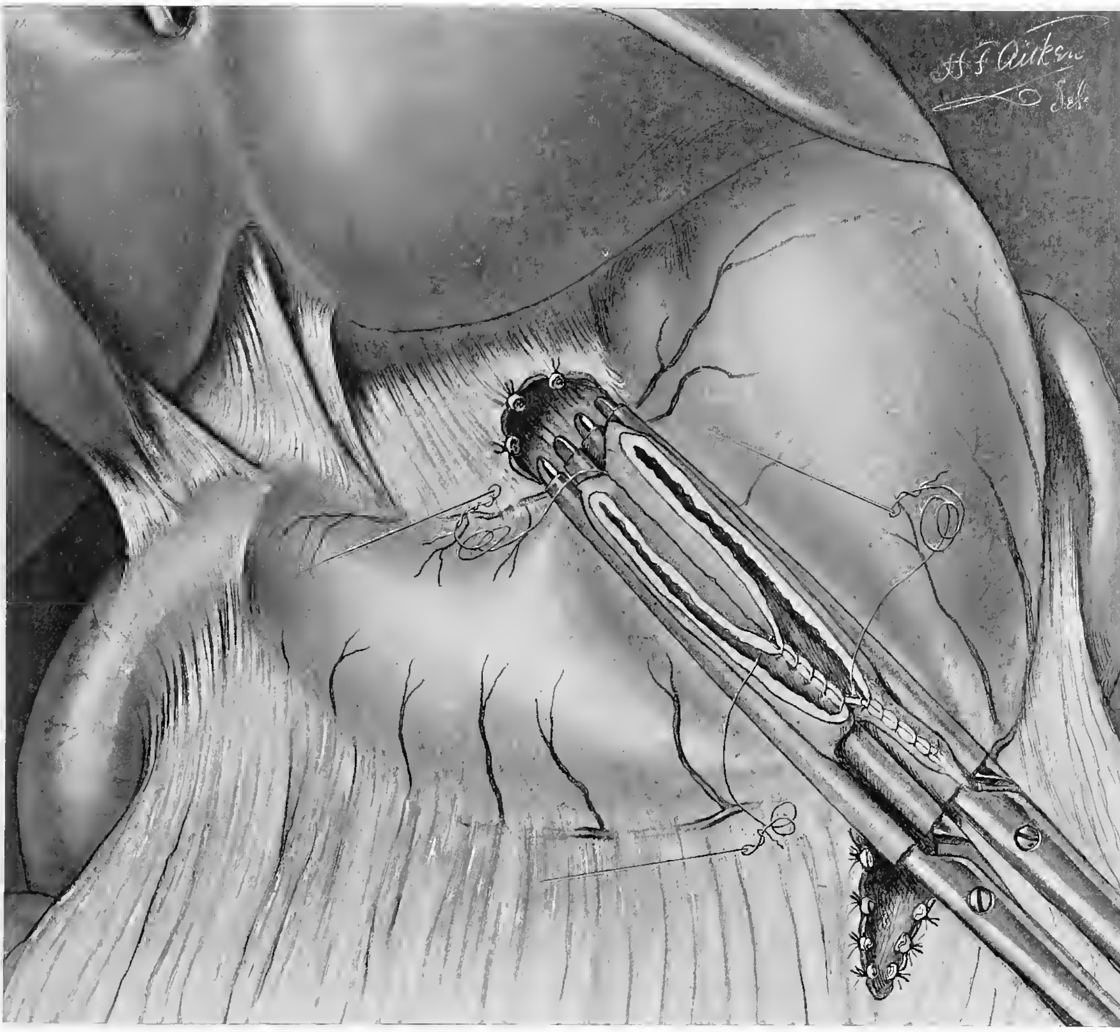

FIG. 181.—RESECTION OF THE MIDDLE PORTION OF THE STOMACH.

End-to-end anastomosis of stomach after resection. Clamps turned to present cut edges. First half of seromuscular stitch placed. Through-and-through stitch begun; overlapping portion on greater curvature closed in.

the Connell interrupted mattress suture to this situation, while Moynihan and others sew the cut edges together in two layers. As the second method is the one more generally used, this technic is described below.

The anastomosis consists of outer continuous seromuscular and inner continuous through-and-through stitches. Upon bringing the two clamps side by side, it will be found that the upper portion of the stomach has a larger caliber than that of the lower. The two openings are brought to

Fig. 182.—Resection of the Middle Portion of Stomach.
Suture completed. Omenta approximated. Overlapping portion on greater curvature turned in with mattress sutures.

the same caliber by taking a reef in the larger, and the anastomosis performed as follows: The clamps are held together, in such a manner that the line of the lesser curvature is restored, leaving the redundant edge of the upper portion to overlap on the greater curvature. The handles are now given a quarter turn, so that the cut edges project forward, thus facilitating the introduction of the first half of the seromuscular stitch, which is placed in the space intervening between the cut edges and the clamps (Fig. 181). The redundant edges of the upper portion are sewed

together with a continuous stitch, and the remainder of the anastomosis done in the usual manner. The slip of walling-off gauze is afterwards removed, and the omental incisions closed with interrupted sutures (Fig. 182).

When a very large section of the middle portion of the stomach has been removed it will be found preferable to join the distal segment to the greater curvature of the proximal segment, in a way similar to Billroth's first technic for pylorectomy.[1] In this manner the best drainage is obtained. After resections which leave the openings of the upper and the lower segments at approximately the same caliber it is simpler to restore the lesser curvature, as described earlier, and turn in the edges of the upper segment which overlap at the greater curvature.

EXCISION OF ULCER.

The suspicion that an ulcer is underlying malignant degeneration warrants the excision of the doubtful area. When the ulcer is accessible, the technic is obvious. Excision of an ulcer on the lesser curvature requires more elaborate technic. Vallas[2] has described a case of this type, and his method is adopted below:

Steps:

(1) Clamps.

(2) Excision of V of lesser curvature.

(3) Anastomosis, line of lesser curvature restored.

The gastric artery is tied double, and cut, on each side of the diseased area, as has been described before. The lesser omentum is ligated in sections to include the glandular masses adjoining the gastric lesion, and the clamps applied. These are placed about one inch outside of the extreme limit of induration to take in a V-shaped section of the lesser curvature. This V includes a portion of both stomach walls, with its base above and its apex below. If the tips of the two clamps touch at the apex of the triangle leakage from the stomach will be prevented. The excision is now done with scissors, leaving an ample free edge projecting from both instruments (Fig. 183). Vallas found great difficulty in applying two layers of sutures to the posterior edges of the opening; the Connell mattress method is more applic-

[1] Clark. Journal Am. Med. Asso., Chicago, 1905, XLIV, 1613.

[2] Vallas. Lyon Médical, 1905, CIV, 404–407.

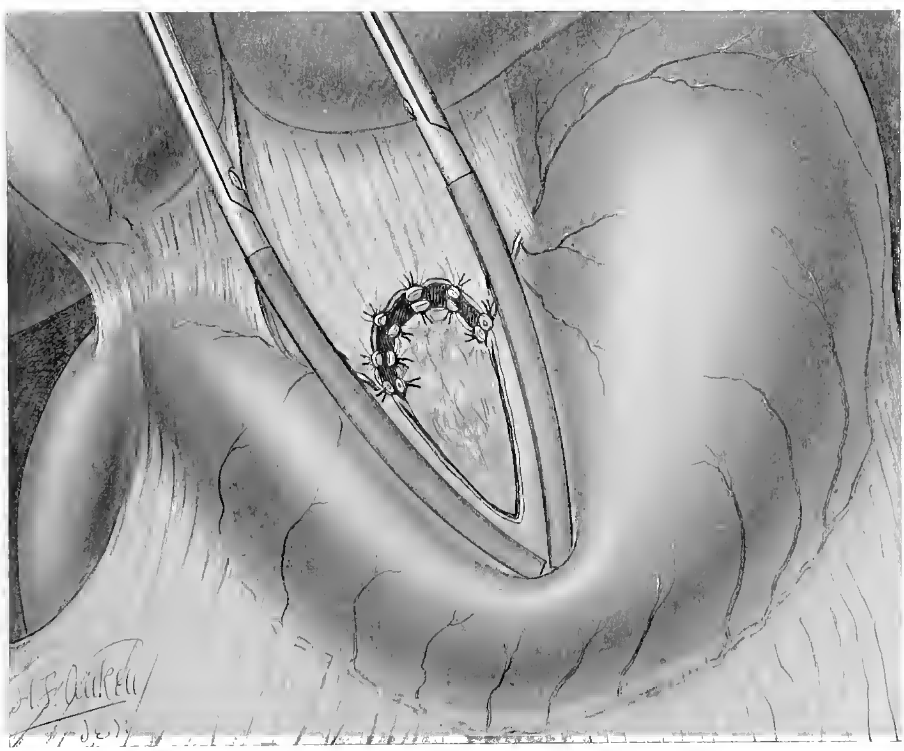

Fig. 183.—Resection of an Ulcer on the Lesser Curvature.

Clamps. Vessels tied. Excision of triangular portion of the stomach, on lesser curvature. Excision of glands in the lesser omentum.

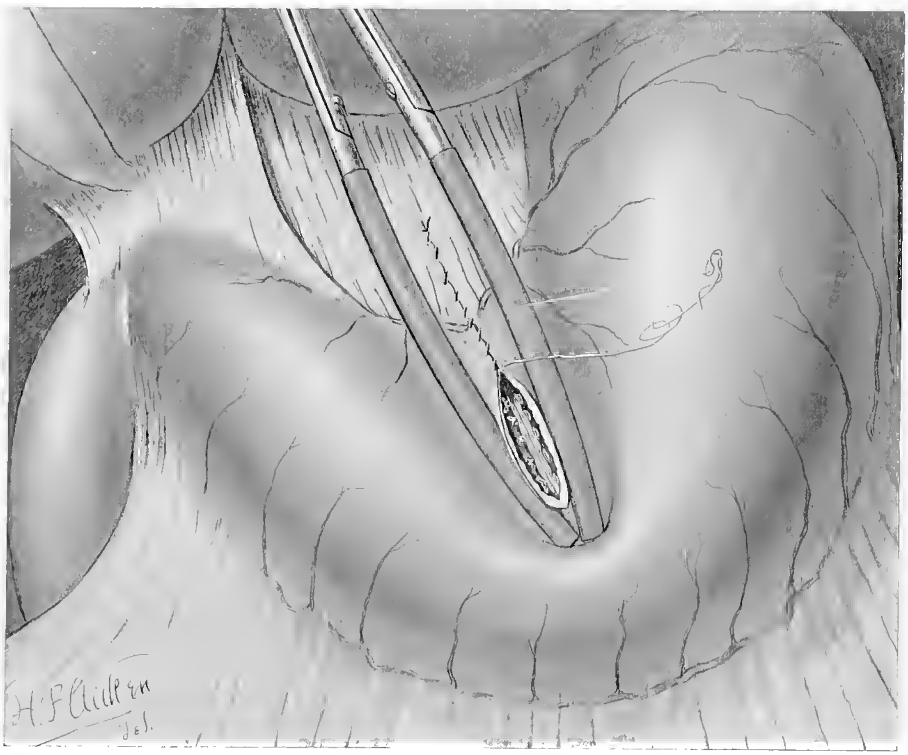

FIG. 184.—RESECTION OF AN ULCER ON THE LESSER CURVATURE.

Posterior edges of wound approximated with Connell mattress sutures. Anterior edges approximated with two layers of continuous stitches.

able. These stitches can be put in, from apex to base, until the lesser curvature is reached, after which the front can be closed in with two layers of continuous stitches, as usual (Fig. 184).

GASTROPLASTY.

The operation described below consists in the application of the Heinecke-Mikulicz principle of pyloroplasty to a stricture in the body of the stomach.

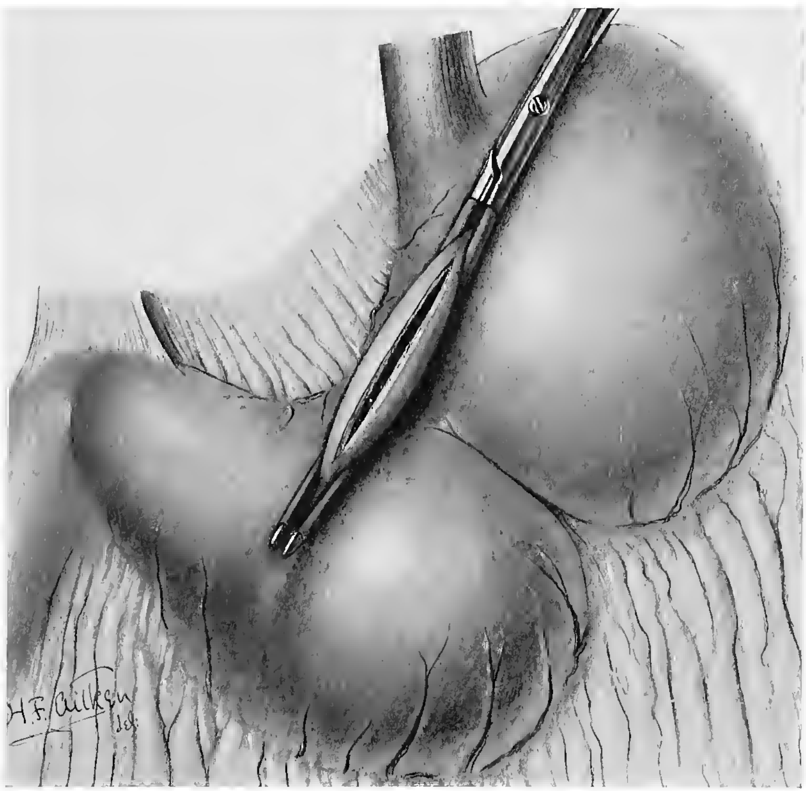

FIG. 185.—GASTROPLASTY FOR HOUR-GLASS STOMACH.
Clamp first applied parallel to long axis of stomach. Stomach opened; mucous membrane trimmed flush with muscle.

The purpose of the operation is to increase the caliber of the stomach at the site of the constriction. Its use is advocated by Bardeleben,[1] Kruckenberg,[2] Eiselsberg,[3] and others.

[1] Bardeleben. Klemperer, Berliner Klin. Woch., 1889.
[2] Kruckenberg. Schmidt-Monard, Münch. Med. Woch., 1893, No. 19.
[3] Eiselsberg. Archiv für Klin. Chir., 1899.

Steps:

(1) Clamp applied in long axis of stomach.

(2) Incision into fold included by clamp, with excision of redundant mucous membrane.

(3) Clamp removed, incision pulled out until at a right angle to its original position, and clamp reapplied.

(4) Wound sewed together with two layers of sutures.

The object of the clamp is, of course, to control hemorrhage and to prevent leakage of the gastric contents. It grasps a fold in the long axis of the stomach, after which an incision is made through the fold held by the clamp, and the redundant mucous membrane excised (Fig. 185). The middle points on the lips of the wound are then seized with forceps and the clamp loosened. The two middle points, grasped by the forceps, are now separated from each other by pulling upward with one hand and downward with the other hand, at the same time lifting forward. This prevents leakage while the other clamp is off, and leaves the incision at a right angle to its original direction. The clamp is next tightly reapplied, thus holding the cut edges in their new position (Fig. 186). The points which correspond to the angles of the original incision are now in the middle of the clamp blades. These points will tend to retract, and should be pulled well through the blades and held fast, if necessary, with small hemostatic forceps. The incision is sewed together with two layers of sutures, an inner through-and-through, and an outer seromuscular, both of which are continuous. The clamp is removed before placing the outer suture, for the usual reasons.

GASTROGASTROSTOMY.

In 1894 Wölfler[1] first performed intergastric anastomosis between the two pouches of an hour-glass stomach, since when it has been frequently done in suitable cases. The operation is essentially a lateral anastomosis.

Steps:

(1) Clamps.

(2) Lateral anastomosis.

The clamps are placed across the stomach, taking up long folds. The lower

[1] Wölfler. Beiträge zur Klin. Chir., 1895, No. 13.

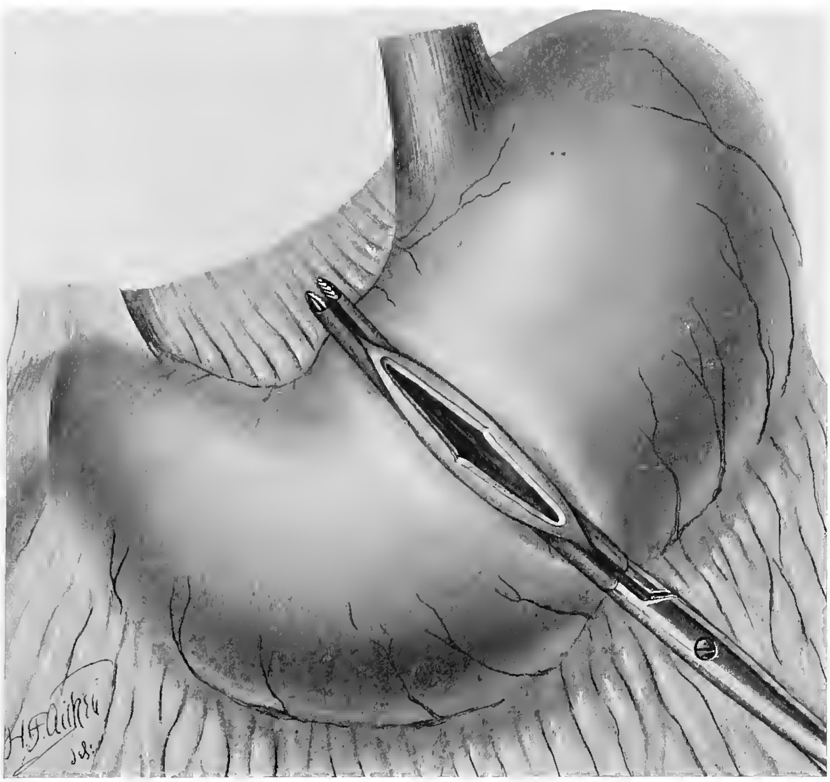

FIG. 186.—GASTROPLASTY.
Line of incision drawn out until at right angles to original position; clamp reapplied to hold edges in new position without hemorrhage.

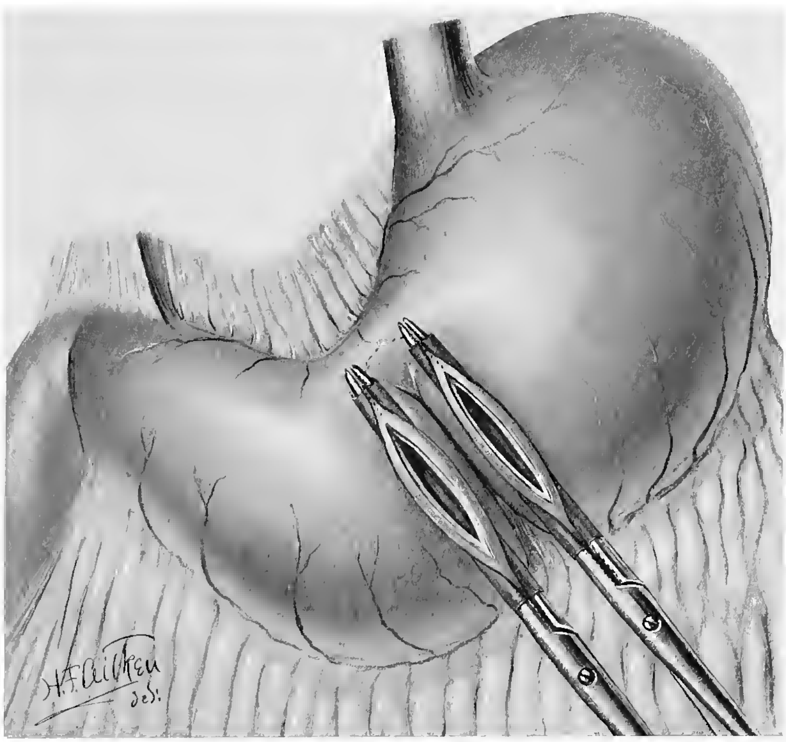

Fig. 187.—Gastrogastrostomy for Hour-glass Stomach.

Clamps in position for lateral anastomosis; folds open; dotted line shows Kammerer's method of connecting two incisions and applying Finney's technic.

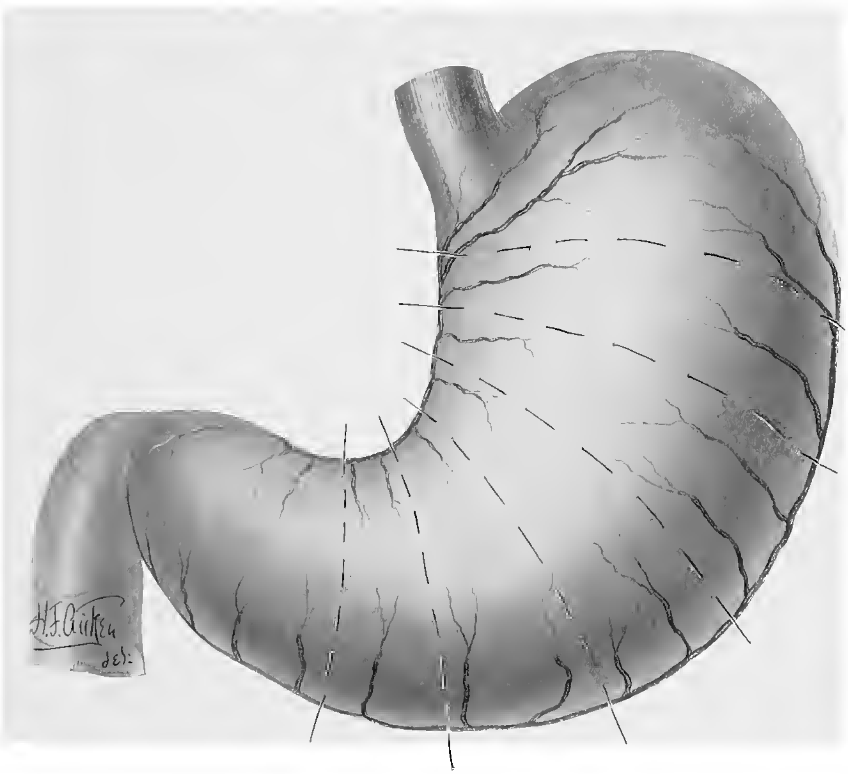

FIG. 188.—GASTROPLICATION.
Method of placing the stitches in the anterior wall.

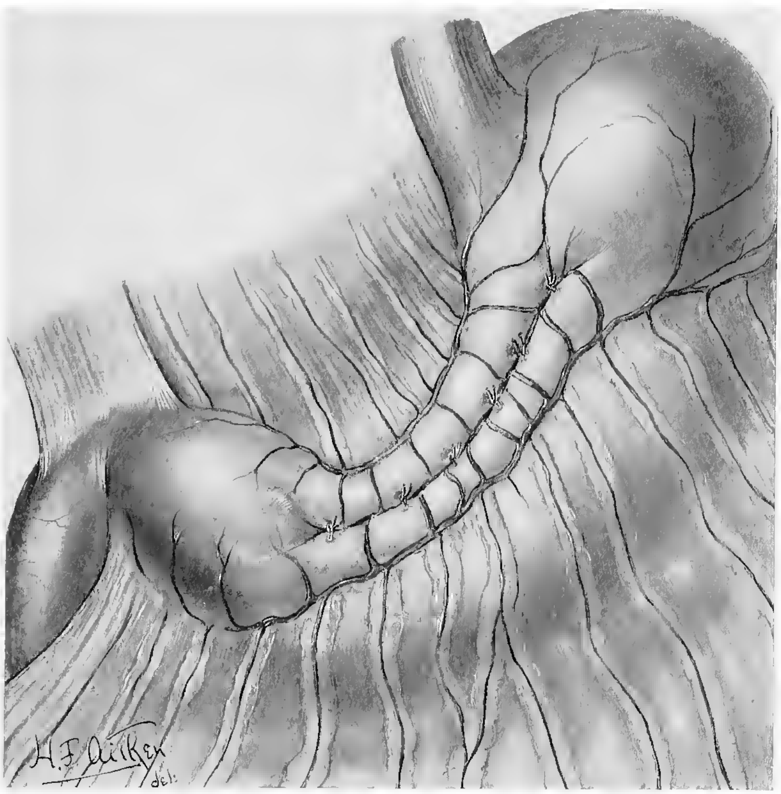

FIG. 189.—GASTROPLICATION.
Anterior wall plaited by tying the stitches.

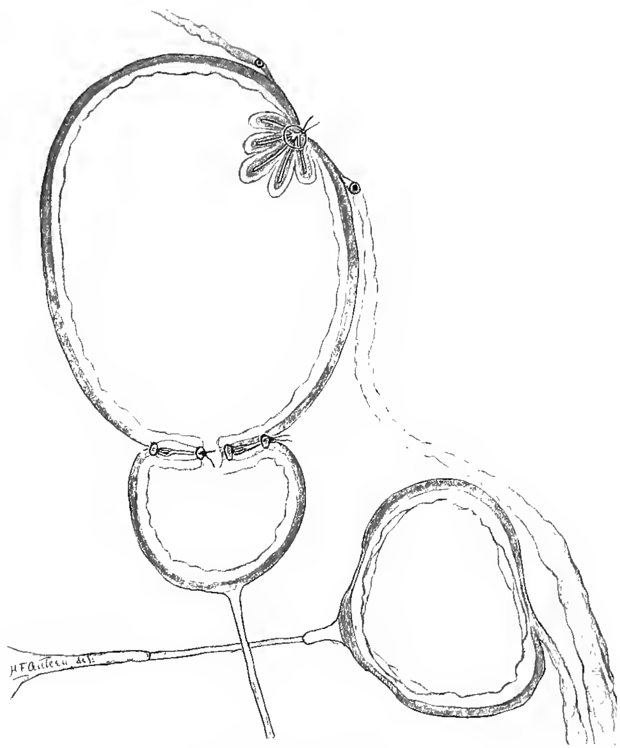

FIG. 190.—GASTROPLICATION.

Cross-section showing plaits in the anterior wall. Posterior gastroenterostomy.

angles of the folds include portions of the greater curvature and omental attachment, for the incisions necessarily are made low to obliterate the pouches (Fig. 187). The usual technic for lateral anastomosis is adopted. Kammerer[1] has successfully applied Finney's gastroduodenostomy technic to gastrogastrostomy. The dotted line in Fig. 187, connecting the upper angles of the clamped folds, shows Kammerer's method of converting a simple gastrogastrostomy into Finney's operation. For directions as to the application of the clamps for Kammerer's operation the reader is referred to the technic of gastroduodenostomy, page 229.

GASTROPLICATION.

Folding of the stomach, to diminish its size, is said to be indicated in those rare cases of atonic dilatation of the stomach not caused by obstruction of the pylorus. The operation was originated by Bircher,[2] in 1890. It has been performed since then, with a certain amount of success, by Weir,[3] Bennett,[4] Brandt,[5] Moynihan,[6] C. B. Porter,[7] and others. Moynihan's technic is given here:

(1) A series of interrupted seromuscular stitches are placed across the anterior wall of the stomach.
(2) The tying of these stitches folds in the stomach.
(3) Posterior gastroenterostomy.

Moynihan has modified Bircher's and Weir's technic. He introduces a number of interrupted stitches which start from the lesser curvature and travel across the body of the stomach, parallel with each other (Fig. 188). Each stitch comprises a series of bites taken in the anterior wall of the stomach, about one inch apart. Upon drawing tight the threads, the stomach wall is folded into as many creases as there are bites in each stitch. Great care must be taken not to cause obstruction by placing the stitches too close to either aperture of the stomach (Fig. 189). Moynihan does

[1] Kammerer. Annals of Surgery, 1903, Vol. XXXVII, p. 281.
[2] Bircher. Correspondenzbl. für Schweiz., Aertze, 1891, p. 713.
[3] Weir. New York Medical Journal, 1892, July 9, p. 29.
[4] Bennett. London Lancet, July 4, 1896, p. 8.
[5] Brandt. Cent. für Chir., 1894, p. 36.
[6] Moynihan. London Lancet, April, 30, 1898, p. 1177.
[7] Porter, C. B. Trans. American. Surgical Asso., 1897.

not attempt to plait the posterior wall, since this difficult move has not given the best results. He was once obliged to add a posterior gastro-enterostomy on a return of the symptoms, a measure which proved wholly successful. It would seem advantageous to perform the gastroenterostomy at once, in view of the fact that a deep pouch is otherwise left in the posterior wall (Fig. 190).

INDEX OF NAMES.

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